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Forthcoming Events.

APRIL 20.

Institution of Production Engineers:—General meeting in London. "Light Alloys," Paper by Dr. L. Aitchison.

Institute of British Foundrymen.

APRIL 21.

Birmingham, Coventry and West Midlands Branch:—Annual meeting at Birmingham. "The Foundry Accident Problem," Paper by W. Morgan.

APRIL 22.

Middlesbrough Branch:—Annual meeting at Middlesbrough.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Foundry Industry as a Separate Entity.

On many occasions both in this column and elsewhere we have done a certain amount of propaganda with the object of obtaining for the foundry industry statistics conducive to its well being. In this connection we were recently asked by a high authority to state the various divisions into which the industry could profitably be divided so that material of a maximum value could be collected. Primarily, there are the two main divisions—ferrous and non-ferrous. It is proposed on this occasion to deal with the former only, which embraces three distinct categories—steel, cast iron and malleable iron.

The information which is sought under the heading of steel castings is the monthly (or other periodical) output, import and export, of heavy, that is, weighing more than 1 ton; medium, that is, ranging between 1 cwt. and 1 ton, and light that is, less than 1 cwt. of steel castings. A second useful piece of information would be an indication of the quantity of alloy steel castings—though obviously in this case the definition of the term would create difficulty.

There is to sit in the near future a commission which is to decide whether steel castings shall be so marked as to indicate their country of origin. In the ordinary way the British manufacturers are cognisant of locality from which they receive the bulk of their competition and some of them would appreciate a better classification in the Board of Trade Returns. As machinery is largely an aggregation of castings, a relatively unimportant amount of machining can and does change the classification, whilst quite often such a procedure intensifies the competition. We hope that this aspect will be discussed at the forthcoming meeting, and at least a recommendation will go forth for a study of imported machinery viewed from the angle of the foundry owner being undersold by foreign goods.

The question as to whether iron castings should be similarly dealt with must be uppermost in the minds of many of our readers, but we feel that they should attempt to classify themselves as it may be that certain sections do not feel any foreign competition. As a preliminary we suggest the following subdivisions, which go to make up that vast and important industry: Pipe, textile, automobile, agricultural, large and small electrical, printers', light builders', rolls, municipal, railways, marine, mining and hardware. Malleable castings probably need no subdivision, but attention is drawn to the large quantities being imported and being classified as "fittings" for various industries.

Thus the question arises with ever-growing importance, that there is a need for all the various foundries to attach themselves to the existing masters' federations; to resuscitate the various derelict foundry group associations, and to realise that there are questions other than wages and selling prices which require their co-operative study. A foundry, formerly attached to a now non-existent group, consulted us only last week as to a dispute they were having with the Inland Revenue Authorities as to the amount of depreciation which could be allowed on foundry plant. Whatever figure is finally arrived at it should be general in application, but there remained no machinery for consultation, let alone joint action. Britain's business has been built up by individualism, but we suggest that modern conditions demand that co-operation is not merely desirable but essential.

Belgian Foundrymen's Association.

The annual meeting of the Belgian Foundrymen's Association opened last Saturday morning at Brussels, under the chairmanship of M. Paul Ropsy. In his address, he took the opportunity to thank the American Foundrymen's Association and the Institute of British Foundrymen for the hospitality shown to himself and his compatriots at their respective conferences. He referred to the work of the International Committee in having straightened out to a large extent the chaotic conditions with respect to conferences and exhibitions of an international character, which existed prior to its formation. During the morning M. Lamoureux presented a Paper by Professor Potter, of the Minnesota University. The subject related to the heat treatment of grey iron and semi-steel, and created an animated discussion. This and the other five Papers will be dealt with in future issues.

The Congress closed on Sunday morning with a luncheon. The affair was given quite an international flavour, as speeches of thanks for hospitality received were given by Dr. Werner, M. E. Ramas, Mr. V. C. Faulkner, Mr. V. Delport, Mr. L. H. Stoffel and Mr. J. M. España, whilst M. Rabozée delivered a discourse on the subject of the relative positions of the scientist and the practical man in the foundry industry.

Amongst well-known foundrymen present were MM. Ronceray, Varlet, Lamoureux, Pieboeuf and Masson. Great Britain had representatives in Messrs. Faulkner, Makemson, Castle, Beecroft and Crawshaw.

The International Foundrymen's Committee.

A meeting of this Committee was held last Saturday evening at the Hotel Ravenstein, Brussels, under the presidency of M. Paul Ropsy (chairman of the Belgian Foundrymen's Association). Amongst those present were Dr. S. G. Werner, vice-president (Germany), Mr. V. C. Faulkner (Great Britain), MM. Petit and Ramas (France), Mr. V. Delport (America), Mr. G. H. Stoffel and Mr. Vannienherten (Holland), MM. Varlet, Ivan Lamoureux and Ledent (Belgium), and Mr. J. M. España (Spain). Mr. Tom Makemson was present as honorary secretary.

The meeting dealt with the schedule of forthcoming conferences for the next decade, and support was promised for those to be held in Paris next September, in Spain in 1928, and in London in 1929. The finances of the Committee were satisfactorily arranged. An endeavour is being made to make this Committee as representative as possible of all foundry organisations in the various countries represented, in order that there may be no clashing of interests and to ensure that any steps it may take will be a reflection of the widest possible field.

After the meeting the representatives were entertained to a private dinner by M. Ropsy. It was of an informal character, but Dr. Werner did, on behalf of the guests, express their profound pleasure at being present, and to experience their host's generous hospitality.

Catalogue Received.

Heating and Drying.—The British Drying & Heating Company, of 14, Waterloo Place, London, S.W.1, have sent us an advance copy of a brochure they have prepared on the subject of heating and drying propositions, as applied to foundry practice. It is a 16-page booklet, jacketed in blue, and describes and illustrates the Oehm Patent Portable Heating Element, a stove which is run off the compressed air mains. A graph, however, is given with the object of showing that it is unnecessary in many cases to run a compressor throughout the night. The brochure is full of facts and figures, which make it extremely useful for the foundryman, to whom we understand it is available on application.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Carsil Process.

To the Editor of The Foundry Trade Journal.

Sir,—The article in your issue of March 17, on the subject of the direct production of steels from ores, may or may not have provided new information or data on a topic of undoubted interest—that is a point for steel makers and metallurgists to determine.

As a business man who endeavours to keep pace with the march of progress in many spheres of industrial activity, and who appreciates that sound new or improved methods must inevitably prevail over the old, it seems to me very desirable indeed that the most careful investigation should be made to determine how and in what manner the consuming markets can be supplied more economically, more expeditiously, and more satisfactorily.

Assuming the "Carsil" process (or any other process) is, as appears to be the case, an actuality, that quality steels can be made without prior conversion of ores to pig-iron in blast furnaces, which involve heavy capital and working expenses, and that such steels compare favourably when tested with the normal commercial qualities, there appears to be only one factor which calls for attention. I mean the actual cost of production or conversion.

What are the essentials of expense in the process? They are:—(a) Cost of ores delivered to the furnace site; (b) cost of electric current, and electrodes; and (c) overheads, labour, etc.

From a business aspect, these expenses seem capable of substantial reduction as compared with high cost of current, high labour charges, and high administration costs in Great Britain. Blast furnaces are dispensed with, and the steels can be made in small quantities, presumably also in larger quantities, thus avoiding the heavy capital and working expenses at present involved.

By putting up a suitably sized plant on sites at or adjacent to those deposits of ores or metallic sands which are in close proximity to water power for the production of electric current, all the items (a), (b), and (c), are at once substantially reduced. Freight and transport expense is only incurred on actual steel, a great saving as compared with ores; the cheapest form of electric current is used, and local labour would be utilised for all heavy work.

Hence the only serious argument made against the one-process method of steel-making can be negatived by a wider grasp of the potentialities of the situation. To consider what is, in my opinion, such an important matter as a revolutionary and seemingly successful new method of steel-making, from an insular aspect, as one of your correspondents has done, appears to me to be wrong. Does not this process open the door to the establishment of many small (as compared with existing huge) steel plants producing quality steel right in the markets existing in our Dominions or in foreign lands?

I fully realise that there are many factors involved in such a procedure, but the whole question seems to warrant a thorough investigation by a selected group of steel makers and business men. I do not imply that steel makers are not business men—such a thought is far from my mind. Cannot such an investigation or conference be arranged?—Yours, etc.,

N. A. Adams.

15, St. Mathew's Avenue,
Surbiton, Surrey.

Mr. William Milligan, late foundry manager to Messrs. Mather & Platt, Manchester, has been appointed foundry works manager of the Alfreton Works of the Stanton Ironworks Company, Limited.

New Premises of the British Cast-Iron Research Association.

In the course of a Paper read before the Institution of Mechanical Engineers in December, 1925, Mr. J. G. Pearce, B.Sc. (Director of the British Cast Iron Research Association) said:—

"Neglect of research on cast iron in the past has not been due merely to the conservatism of the industry, nor even to the difficulty of controlling the pig-iron from which the castings are made. Some at least of the difficulty is attributable to the peculiar necessity in dealing with cast iron for co-operation between the practical man and the technical man."

In that statement Mr. Pearce concisely summed up the whole position. The research work of our national institutions, universities, etc., or rather the value of that work, has too often been lost to the manufacturing industries concerned because it was only the highly-trained technical men who were engaged in the industries who were able to bring to a practical and commercial issue the results of laboratory research. Even in the largest of our foundries the scientific staff is perforce engaged in the main upon routine work, and with very limited time available for experimental work, which for the time being is considered outside works requirements. But a considerable number of the foundries in this country are comparatively small concerns, to whom the employment of an independent scientific staff would be a financial impossibility.

In order to ensure the maintenance of our position in the production of iron castings, it is not only necessary that we should make up the leeway that has been allowed to develop, but it is essential that a real effort must be made to lead the industry. The desideratum is obviously a connecting link between the national universities and other scientific institutions and the manufacturers of castings.

It was with this end in view that the British Cast Iron Research Association was formed in June, 1921. Lack of financial support, however, very seriously crippled the Association in its early days, and indeed, it was not until early in 1924, when Mr. Pearce was appointed Director of Research, and a few months later also took over the secretarial duties, that a change for the better in the fortunes of the Association commenced to materialise, since when the membership has shown constant and gratifying increase.

It should be clearly stated that routine work is not undertaken by the Association, neither is it competing with any of the existing scientific institutions; indeed, the assistance of such institutions is frequently sought to deal with complex problems that come before the Association. The operations of the works laboratory are also entirely outside the scope of the Association's work. Its first function is to "practicalise" the investigations of the scientific institutions—work which demands wide scientific knowledge combined with a practical experience of the industry. To this end the Association addresses itself primarily to the solution of problems of immediate practical importance. A sufficiently formidable list, it must be admitted. The work at present in progress includes:—

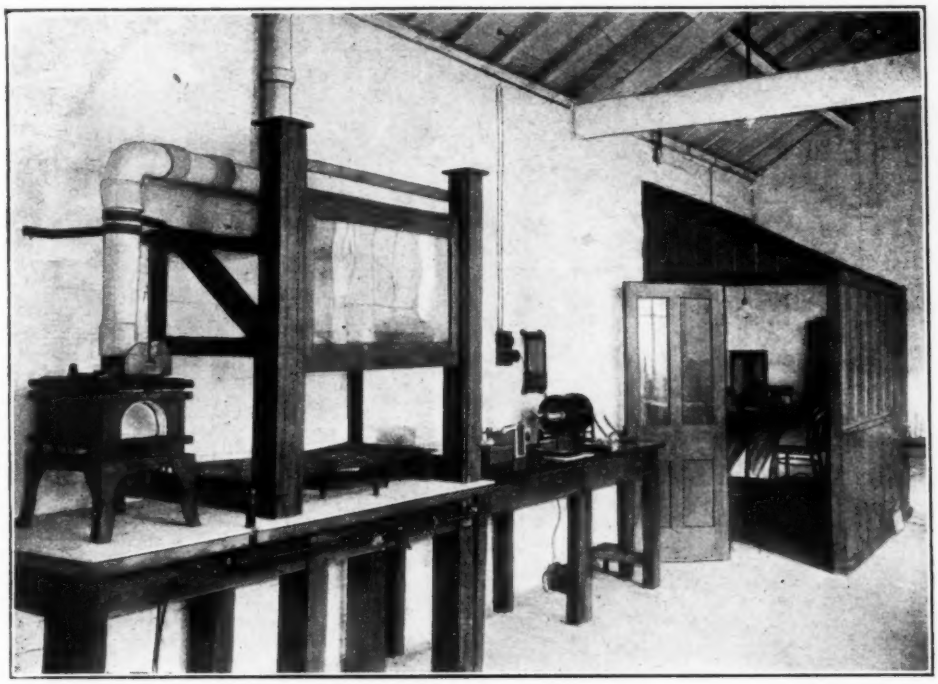

Fig. 1.—View in Laboratory.

(1) *Corrosion-resisting Cast Iron.*—The aim being to develop suitable mixtures of cast iron in the cupola, capable of being machined and possessing good mechanical properties, and yet having much greater resistance to corrosion and erosion than ordinary grey iron.

(2) *Moulding Sands.*—To examine the properties both in the laboratory and in the foundry of a complete range of natural British moulding sands, and to devise tests for their control and mixing in the foundry.

(3) *Graphitisation of Iron.*—To study the influence on the formation of graphite in a synthetic cast iron of the various elements present with a view to learning more about the size and distribution of graphite and its influence on properties.

(4) *Heat-resisting Cast Iron.*—This investigation aims at revealing the constitution of cast iron best calculated to resist heat, and to ascertain further the variations required to suit particular industrial applications.

(5) *Production and Treatment of Malleable Cast Iron.*—This investigation aims at studying certain abnormal failures and defects which arise in connection with the production of malleable castings, both in the cupola and in the crucible. It also covers a complete study of the production of malleable iron. The influence of total carbon, of nickel and chromium.

and of grain size on the mechanical properties are now being examined.

(6) *Cupola Practice and Temperature Measurement.*—An investigation intended to provide information on the best dimensions, charging weights, air supply, etc., for the cupola furnace as used in the ordinary foundry.

(7) *Properties of Grey Iron.*—A study of the whole properties—physical, chemical and microscopic—of a series of ordinary grey irons from British pig-irons, covering the whole range of British grey-iron practice, together with a complete history of the metal from the time it enters the cupola.

(8) *Blackings and Plumbagos.*—A consideration of the composition and properties of, and practical results from, facings of blackings and plumbagos.

(9) *Pearlite Cast Iron.*—To ascertain the physical, chemical, and microscopic properties of cast irons yielding an all-pearlite structure, and to study the precise influence on these properties of heat-treatment of the metal.

(10) *Equilibria of Iron-Carbon Alloys.*—To determine the equilibrium curves of the alloy systems iron-carbon-silicon, iron-carbon-manganese, and iron-carbon-phosphorus.

(11) *Influence of Elements on Chill.*—To determine the precise influence of total carbon, silicon, manganese, phosphorus and sulphur, and of pouring temperature, on the character and amount of chill in cast iron.

(12) *Irons for Light Castings.*—To determine appropriate mixtures of irons suitable for light castings and capable of withstanding fracture in transit.

This work is being carried out by fully-qualified investigators on the staff of the Association through the following three channels, all of which are utilised at appropriate times during each investigation: (1) Laboratory investigations in a University laboratory, in the laboratory at a member's foundry, or in the laboratory of the Association. (2) Works investigations on a full-size scale in foundries and works of members. (3) Chemical, microscopic, and mechanical tests incidental to investigations in the Association laboratory.

Quite apart from the immediate requirements of the industry and the solution of the day-to-day difficulties of the members, there is obviously an almost unlimited field for fundamental research. The value to the foundry industry of the work accomplished during the past two years is such as to warrant the fullest measure of support of every British ironfounder.

Up to a couple of years ago the whole of the analytical work and the testing work was done in outside works—an arrangement which was neither expeditious nor efficient. To meet this deficiency a small laboratory was hired, but with the ever-increasing demands upon it this was speedily outgrown. The Association management were fortunately able to acquire premises in St. Paul's Square, Birmingham, which is conveniently central and where the roominess of the building permitted of laying out the various investigation departments to the best advantage, as also to provide a much-needed increase in accommodation of the administrative offices.

The Chemical Laboratory is equipped with the usual range of apparatus for analysis, etc., and adjoining this is a small machine shop containing a lathe, drilling machine, saw, etc., mainly used for the preparation of test-pieces. Hardness tests are made on the Brinell system, and there is a repeated-impact testing machine. This last consists essentially of a hammer lifted by a cam and allowed to fall on to the centre of a horizontal, end-supported test-bar, which is machined to about $\frac{3}{4}$-in. dia. and has a groove cut in the centre. The bar is rotated through 180 deg. between each blow, the speed of the blows being about 70 per minute. The energy of the blow can be varied from about 0.15 ft.-lb. to 1.0 ft.-lb., using weights of $4\frac{1}{2}$ and 9 lbs. and drops of 0.4 and 1.2 in. It is found that this test enables cast irons to be classified broadly as of high or low impact resistance, and this is very important in the evaluation of high-quality cast irons such as are now being produced in this country and abroad. The machine is driven by a small electric motor housed in the base. The number of blows is automatically recorded, and the machine is automatically stopped when the bar breaks.

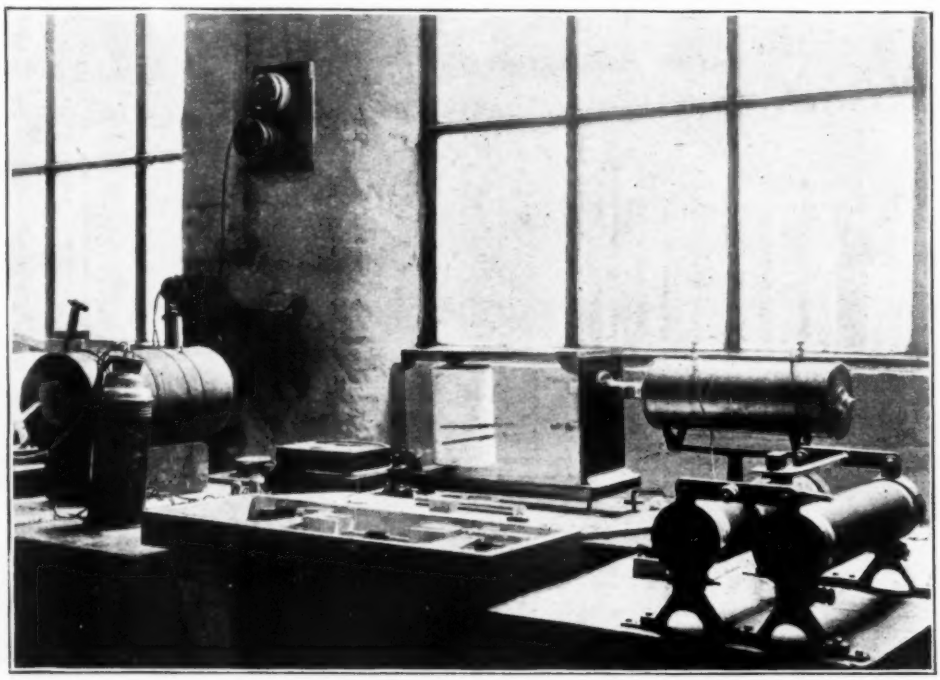

Fig. 2.—Chevenard Industrial Thermal Analyser.

The research work in connection with Heat-Resisting Irons is being conducted by Mr. E. Morgan, M.Sc., and in this department is installed a Chevenard industrial thermal analyser which is used for studying the thermal changes in cast iron. It is essentially a dilatometer, differing from the usual type in that the temperature of the test sample is measured by the expansion of a standard rod of Ni-Cr-W alloy, placed inside the test sample. The standard expands uniformly up to a temperature slightly over 1,000 deg. C. without showing any of the critical changes that usually occur in alloys; it consequently gives a record of the temperature. Thermal changes such as transformation of phases, reaction between phases, etc., are almost invariably accompanied by volume changes, and consequently when an alloy

such as cast iron is heated, such thermal changes are manifested on an otherwise uniform expansion temperature curve as distinct breaks. The dilatometric method of studying the thermal behaviour of alloys has distinct advantages over such methods as the measurement of E.M.F. in that it is entirely independent of external changes.

The instrument is used for measuring critical points, magnitudes of various reactions which occur when cast irons are heated, and the thermal expansion coefficients at all temperatures. It is

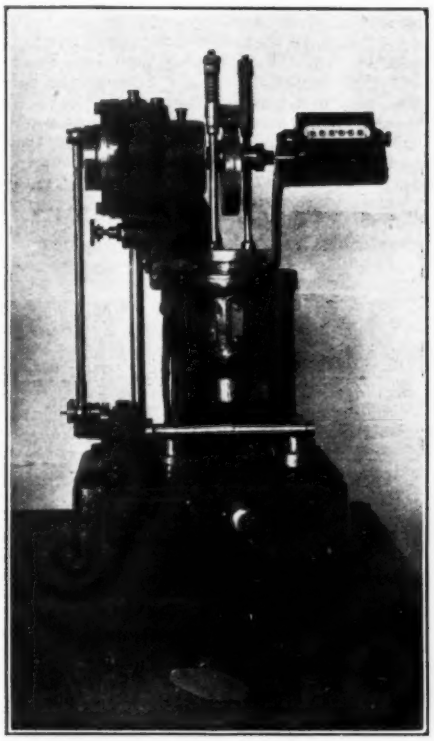

Fig. 3.—Impact Testing Machine.

particularly useful in the work which is now in progress.

Another test employed for heat-resisting irons is the repeated heating test. Bars 6-in. long machined from the casting to be examined, and are given a treatment closely approximating the service conditions. The bars are heated in a small electrically-heated annealing furnace for certain periods at fixed temperatures, and the lengths measured after each heat. A Zeiss micrometer gauge, which measures the length to one ten-

Fig. 4.—Effect of Casting in Chill.

Mould is shown on left; bars cast in open sand are shown on right (front), and bars cast in chill are shown at rear.

thousandth of an inch on bars 6 in. to 8 in. long, is used for this purpose.

Mr. E. R. Taylor, A.R.S.M., F.I.C., is engaged upon the investigation of Whiteheart Malleable Cast Iron, and as a result of research work carried out by him during the year 1926, on chill-cast malleable, such superior results materialised that a patent was taken out to cover the process. Licences are granted to members on nominal terms. By this method of casting, tensile strength, elongation, and bend properties are all very appreciably increased, especially the bend. The latter test (using cupola metal) performed by bending a bar 8-in. × 1-in. × ¾-in. round a 2-in. dia. mandrill gives a bend of 180 deg. with ease, the bar still remaining free from any sign of fracture. The metallurgical explanation is that the chill-cast metal solidifies so quickly in the mould that the grain size of the metal remains very small and retains its austenitic character. During subsequent annealing this small grain size persists right through to the finished malleable, the austenite areas giving place to small ferrite areas. Similar metal cast in the ordinary sand moulds gives a very moderate bend of 45 deg., and this is the type generally produced in the foundry.

From this department, also, results of researches have already been published on the effect of sulphur and manganese on malleable, so that these elements can now be specified by the foundry manager when ordering his pig-iron.

The effect of total carbon has also been investigated. The curves obtained render it possible to predict the probable mechanical properties from any iron of known carbon content and length of annealing period.

When the investigation of the effect of silicon, nickel, and chromium has been completed, Whiteheart malleable metal will be placed on a better and firmer footing than has hitherto been attempted. All the casting operations are carried out in members' foundries, as many as 600 test bars have been cast for one investigation.

There is a well-equipped Micro-Photo Department, the work turned out being of a particularly high standard. An excellent library is in process of formation which, as a means of reference, will in the near future form a valuable addition to the functions of the Association. All the technical journals are searched by members of the staff and all cuttings are indexed and docketed. Some twenty journals which deal directly with the cast-iron industry are retained as permanent additions to the library; the remainder are kept for six months. In the case of valuable contributions in the foreign journals translations are made and filed. The more important sections of the cuttings are classified separately, the remainder being filed whilst a carefully kept slip-reference system simplifies the location of any particular article. In the Quarterly Bulletin of the Association is published a brief abstract of articles of special interest which have appeared in the technical journals.

Publication Received.

Loughborough College Calendar, 1927.

The object of sending us this publication was in connection with a reply to a letter from Mr. List announcing that the educational authorities at Nottingham had agreed to examine the students in foundry practice studying under his tuition at Mansfield, and was to point out the facilities afforded by this College in a similar direction. It was not clear, however, whether the Leicester College authorities would act in a similar capacity for the outlying foundry centres where classes are being held. It is obvious from a perusal of the calendar, that by a slight modification in the syllabus men could be trained primarily as foundrymen, that is, a combination of a foundry metallurgist and a foundry engineer. In this issue Mr. Wesley Lambert outlines a scheme of training which, with perhaps the addition of a special course in internal transport systems, would cover the essentials of the requirement for the modern foundrymen. The College is obviously conducted on the very best lines; it is splendidly equipped and staffed, and we have assured ourselves that students receive a training, especially in the various branches of engineering in a manner comparable with, and in some cases superior to, that offered by some of the modern British universities and foreign technical high schools.

After being closed down for about two years the shipyard of Craig, Taylor & Company, Limited, Thornaby, reopened on April 4 to make a start upon the orders recently secured for two vessels.

The Influence of Sulphur in Cast Iron.*

By J. E. Hurst.

The influence of the various constituents present in cast iron is always a matter of considerable interest to both foundrymen and engineers. As the maker and user of castings respectively, the interest of both foundrymen and engineers is very often distinctly opposed, and for this reason alone it is very necessary that periodical attempts should be made to review the state of existing knowledge of the influence of these constituents.

At a time like the present, as a result of the coal strike the foundries are constrained to use low-grade, high-sulphur coke, and the last vestiges of pig-iron stocks which have been laid aside owing to their high sulphur-contents. Under these conditions, with the danger of high-sulphur contents in the final castings, the influence of the constituent sulphur assumes a *rôle* of additional importance.

Some years ago the influence of sulphur was regarded as fatal to the production of good castings, and was almost the universal explanation for the defects which are prone to appear in castings. In a text-book on ironfounding published in 1912 the influence of sulphur is summarised as follows: "With an insufficiency of manganese to satisfy the whole of the sulphur, the excess of the latter combines with the iron, so that both manganese and iron sulphides may be present. Of the sulphides, iron sulphide is the more objectionable, as it is readily fusible, and decomposes at high temperatures, gaseous sulphur compounds being given off which, as they escape, give rise to blowholes, and therefore cause spongy, unsound, and weak metal. Further, being readily fusible, it is probably the last constituent to solidify, and as a result it tends to be unevenly distributed and segregates in the middle and upper parts of the casting. Manganese sulphide is not so readily fusible, and the temperature of decomposition is higher." This statement, as a whole, represents the belief of many foundrymen and engineers at the present date, and lest there should be any mistake, we may state at once, without any equivocation, that as a whole it is grossly wrong.

In 1908 Rhead, whilst calling attention to the fact that sulphur is only too often made responsible by the foundryman for all the faults of the metal and the defects of castings, stated that the general effects observed are that the iron is made harder, more rigid, and perhaps brittle, is liable to cast more unsoundly, is more sluggish, contracts more, and is liable to produce drawn and distorted castings (especially in green-sand moulds). To this general statement, in its broad sense, very little exception can be taken, and the fact that Rhead deliberately caused the element sulphur to serve a useful purpose by using it to harden and stiffen otherwise soft metal, is an aspect of the influence of sulphur which will be more readily appreciated to-day. Incidentally, Rhead considered 0.2 per cent. sulphur to be the extreme limit of sulphur which should be present in foundry iron, whilst for good results the amount should not exceed 0.10 per cent.

Very broadly speaking, the more modern views consider that in the presence of sufficient manganese the harmful effects of sulphur are completely neutralised. Modern views, however, do not go so far as to express an opinion as to the maximum limit, if any, of the sulphur-content which can be neutralised in this manner. It is important to refer to the publicity which has been given to various methods of desulphurising cast iron, mostly of Continental origin; to the so-called duplex processes, in which cupola-melted cast iron is refined in subsidiary furnaces. The recent publicity given to such processes would tend to indicate that there exists a school of opinion which, at any rate, is uncertain as to whether the harmful effects of sulphur can be completely neutralised. Putting this on one side for the moment, the theoretical reasoning on which the modern view is based are certain facts regarding the manner in which sulphur exists in conjunction with certain other constituents in cast iron.

It is generally considered that the sulphur may exist in cast iron in the form of two separate constituents, which are the chemical compounds sulphides of iron and manganese respectively. The existence of these two compounds having the respective formulæ FeS and MnS is apparently well founded, although the study of these compounds and their respective solubilities in iron has been very much restricted and rendered uncertain owing to the fact that these systems are very much influenced by the presence of oxides and silicates which are difficult to eliminate in preparing the alloys. Other possible compounds of sulphur with silicon and carbon: sulpho-silicide and sulpho-carbide of iron have been suggested on evidence of a very flimsy nature. The possibility of the existence of such compounds is considered to be very remote.

Manganese Sulphide.

Of the two sulphides above mentioned, if one is of more importance than the other in their connection with cast iron, it is probably the sulphide of manganese. This sulphide has an extremely high melting point of 1,620 deg. C., which is 115 deg. C. above the melting point of pure iron, and approximately 470 deg. C. above the melting point of cast iron of eutectic composition. It has a very low specific gravity of 3.99, which is about half that of ordinary cast iron, and is generally assumed to be insoluble in liquid cast iron within the temperature ranges usually met with in everyday practice.

The assumption of the insolubility of manganese sulphide is supported largely by the manner in which this compound segregates in masses of solidifying metal. The example given in Fig. 3 in a contribution (page 325, Vol. 34) to The Foundry Trade Journal by the author is illustrative of this tendency. This is a sulphur print taken from the cross-section of a 4½-in. diameter cast iron bar approximately 17 in. long. This bar was cast in a hot metal mould, and the marked segregation of the sulphide constituent to the top of the ingot gives some evidence of both the insolubility and the lower specific gravity of this constituent.

Some doubt has been cast on the insolubility of this sulphide constituent, and the fact that it is pure manganese sulphide (MnS). Dr. Stead (Cleveland Institute of Engineers, 1912, page 33), from his examination of blowhole segregates in steel, considers that at high temperatures the sulphur is combined with the iron as FeS, and that at lower temperatures MnS is formed in accordance with the equation

$$FeS + Mn = Fe + MnS.$$

The observation which prompted these considerations is the fact that whilst the segregation of the sulphur was quite marked, that of manganese was negligible. At a later date, in his discussion on Arnold and Bolsover's paper (J.I.S.I., No. 1, 1914, page 396), Stead suggests that the MnS does not solidify pure but as the double compound $Mn_2Fe_2S_3$ (3FeS.2MnS), and that as the mass slowly cools this becomes unstable, and the manganese in the surrounding steel replaces the iron in combination with the sulphur. This double compound is identical with that discovered by Rohl, and which is more properly to be regarded as the saturated solid solution of FeS and MnS.

Further support to this view is forthcoming from the Report on the "Heterogeneity of Steel Ingots," presented to the Iron and Steel Institute this year. In their examinations of various steel ingots the committee who presented this report encountered the same observation that the segregation of the sulphur was not invariably accompanied by the manganese. The committee realised the importance of this, but refrained from advancing any explanation or reason to account for these

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

observations. They definitely stated that the question of the formation and solubility of MnS is one of the matters which must be cleared up by direct experiment.

It is not within the province of this Paper to discuss this question further in relation to steel. Some experiments in connection with cast iron are of interest. When large masses of liquid cast iron are rapidly rotated or "centrifuged," as is done in the commercial centrifugal casting processes, a marked segregation of the sulphur constituent takes place; the constituent invariably moving towards the axis of rotation. The movement of the sulphide constituent in this manner under the influence of the centrifugal action is clear evidence, on a practical scale, of the insolubility and lower specific gravity of the constituent under the temperature conditions of the liquid iron in these experiments.

The segregation of the sulphide constituent is more effective in the case of large masses of molten metal which are so disposed as to maintain themselves liquid for a longer period during the centrifugal operation, thus presenting a more favourable opportunity for the sulphur to segregate.

The analyses taken from the segregated portion and the main body of a centrifugal casting are as follows:—

	Segregated Centre Portion. Per cent.	Main Body of Casting. Per cent.
Mn ...	0.60	0.33
S ...	0.23	0.06

There is here distinct evidence of the movement of manganese along with the sulphur. The manganese remaining in the body of the casting is considerably in excess of the requirements of 0.06 per cent. S to form the compound MnS. If we deduct from this percentage 0.33 per cent. the quota of manganese corresponding to the 0.06 per cent. sulphur present, the amount remaining, viz., 0.2262 per cent., can be regarded as the amount of manganese not in combination with the sulphur. If it is assumed that this portion of the manganese has not been influenced by segregation effects and is evenly distributed throughout the whole casting, one would expect the amount of manganese remaining, after deducting this amount from the total present in the segregated portion, would correspond to the quota required with the sulphur present in this portion to form the compound MnS. The results are set out in Table I.

Table I.—*Distribution of Sulphur in Cast Iron.*

Item.		S. per cent.
1	Sulphur in body of casting	0.06
2	Quota of Mn corresponding to MnS with (Item 1)	0.1038
3	Manganese in body of casting	0.33
4	Manganese in casting not combined with sulphur (Item 3 minus Item 2)	0.2262
5	Manganese in segregated portion ..	0.60
6	Manganese in segregated portion combined with sulphur (Item 5 minus Item 4)	0.3738
7	Sulphur in segregated portion	0.23
8	Theoretical quota of Mn required to form MnS with (Item 6)	0.3979

The value (Item 6) 0.3738 per cent. is sufficiently near the theoretical requirements of the compound MnS, viz., 0.3979 per cent., as could be expected under the conditions of this experiment. In the light of this evidence it may be concluded that in cast iron of the composition used in the experiments, and in the presence of sufficient manganese the sulphur exists largely as the simple manganese sulphide (MnS), and that this compound is insoluble in liquid cast iron at the temperatures met with under ordinary foundry conditions. In addition this evidence is strong confirmation of the lower specific gravity of this constituent.

It is of interest to suggest that the application of this centrifugal method might be applied to the investigation of the condition of sulphur in steel. The American Bureau of Standards have published an investigation on a sample of centrifugally cast steel, and reported a slight segregation of the sulphur towards the inner surface. In an investigation of this nature specially undertaken with the object of determining the condition of the sulphur much larger masses of metal would be used than those dealt with in this investigation.

The modern view that in the presence of sufficient manganese the harmful effects of sulphur are neutralised is based on the above facts. It is considered that by virtue of the insolubility of the manganese sulphide compound, the sulphur in this form is removed from participation in the graphite forming actions which have so much influence on the properties of cast iron.

In all the samples previously illustrated no hard white spots accompanied the segregation of the sulphide. No marked difference was commented upon in the hardness or machinability of the various specimens at the points where the segregations were prominent. This fact indicates at least that MnS has no serious influence in preventing the formation of graphite.

An interesting case of segregation came before the writer's notice some time ago. The analysis of certain segregated lumps which were found on the inside surface of a centrifugal casting was as follows: CC, 0.31; GR, 4.72; Tot. C, 5.03; Si, 4.46; Mn, 1.22; S, 0.69; and P, 1.20 per cent.

The important feature illustrated by this specimen is that, in spite of the abnormally high sulphur-content, the combined carbon has not been maintained at any excessive value. There is sufficient manganese present to convert the whole of the sulphur to MnS. (Admittedly the silicon has attained a high value, but this should be taken in conjunction with the fact that the samples were not more than ¼ in. thick and were cast in metal moulds.)

The experiments of the late Dr. Stead may be used to illustrate the neutralising effect of the deliberate conversion of sulphur present in cast iron to MnS. The addition of 1 per cent. manganese to a white iron containing practically 3.0 per cent. combined carbon and 0.28 per cent. sulphur converted this into a grey iron containing 0.6 per cent. combined carbon. These further examples serve to confirm the modern view that the insoluble MnS is without influence on the condition of the carbon in cast iron, which in its turn supports the view that its influence on the ultimate quality of the metal is not likely to be harmful.

Amount of Manganese Necessary to Neutralise Sulphur

A question which is often asked and which is of considerable practical importance is—What amount of manganese is necessary to neutralise the sulphur? Theoretically, 1.73 parts of manganese are required to form the manganese sulphide with 1 part of sulphur. It is often also asked if this theoretical ratio is sufficient to ensure the whole of the sulphur in commercial cast iron being completely converted to MnS. It is the general opinion that considerably more than this theoretical amount of manganese is necessary. In connection with steel, eight times the amount of sulphur present has been suggested. Levy has stated that the excess of manganese required is likely to be greater in low-carbon alloys than in high-carbon alloys (cast iron).

The necessity for such an excess of manganese has been explained on the grounds that a portion of the manganese is invariably occupied by some other constituent, and that a portion only of the manganese goes to satisfy the sulphur. This explanation is due to Dr. McCance, and appears to the author to be the most rational from the point of view of our present knowledge. The partition of the manganese between the sulphur and whatever other constituent (possibly the carbon) with which it is connected is a subject on which we have no quantitative information. It is reasonable to assume that this partition will be profoundly influenced by the amount of carbon and silicon present, in addition to the actual amounts of manganese and sulphur themselves.

Some extremely valuable information on this point has been recently disclosed by Mr. John Shaw in his recent Paper before the Detroit Convention of the A.F.A. Mr. Shaw has disclosed what might be termed a critical ratio of manganese and sulphur above or below which the

condition of the carbon is profoundly influenced. This critical ratio in Mr. Shaw's examples is about 3 of manganese to 1 of sulphur. All the examples are taken from roll metal having total carbon contents of approximately 3.0 per cent. and silicon round about 0.75 per cent. I think Mr. Shaw's findings may be summarised briefly as follows: (1) When the ratio of manganese to sulphur is less than 3:1 the combined carbon is maintained at a higher value than when the ratio is greater; and (2) in a like manner the depth of chill in large masses cooling under similar conditions is maintained to a greater extent than when this ratio is greater than 3:1.

It is necessary to point out that these ratios may not be exactly maintained in irons of different compositions from Mr. Shaw's examples, and these results might conceivably be interpreted as evidence of the necessity for an excess of manganese over and above the theoretical amount to ensure the sulphur being converted to manganese sulphide. There is, of course, an alternative interpretation which has already been put forward by Mr. Shaw, and it is obvious that further experiment is necessary to determine the exact mechanism of the phenomenon.

Whatever the exact mechanism may be, this is distinct evidence that an excess of manganese is required to neutralise the effect of sulphur, and in low-silicon, low total carbon irons this excess is in the ratio of 3:1 as compared with the theoretical ratio of 1.73:1. On *a priori* grounds it is probable that this excess would be less in irons of higher silicon and total carbon contents.

(*To be continued.*)

Unwritten Laws in the Scrap Trade.

By a Dealer.

It must be a source of satisfaction to all connected with the foundry and metal trades, that serious disputes involving litigation are few and far between, differences of opinion being generally adjusted in a friendly and give-and-take spirit, which does not often necessitate even a resort to arbitration. This is all to the good, but disagreements usually leave a sore feeling behind, whatever settlement may be made, and, in any case, business men have enough troubles to-day without devoting precious time to argument, and the fewer pinpricks in commercial life, the better for all concerned.

In these days of high production costs, quality must more than ever be set in the very forefront of the British manufacturer's programme of work, for a good reputation will often secure orders which would otherwise have gone to the foreigner on price, and to secure and maintain a name for first-class goods it is essential to employ in their manufacture only high-grade materials.

The use of scrap is now so much a part of foundry practice that to ensure a supply of reliable secondary material is every whit as important as to secure well-known brands of virgin metals, and if the buyer fails in his quest for "the goods," it will not be very long before the foreman caster is, metaphorically speaking, asking for that unfortunate buyer's head on a charger. But it would not be fair always to blame the man in the office for the arrival of second-rate scrap in the stores or stock-yard, for he is up against difficulties of which those in the foundry are unaware.

More than ever to-day the scrap buyer's lot is not a happy one, for the pick-and-choose days are over, and to a very great extent he is compelled to "take it or leave it," and only too often, if "take it" is the verdict, the stuff is not what he thought it was when it arrives.

British and Foreign Consignments.

The manufacturer holding a contract for Cleveland pig-iron No. 1 quality knows exactly what to expect when delivery is made, just as does the buyer of electrolytic copper. But the scrap buyer who has purchased a parcel of old rolled brass cannot prophecy, with any degree of certainty, as to the form or quality of the material. Should it prove to be of American origin, the mixture will probably approximate "two-and-one" alloy, and the make-up will show a fearful and wonderful variation in the size and shape of its units. On the other hand, if English rolled brass is sent in, the copper contents will be lower and much of the scrap very light. As to packing, the U.S.A. send consignments forward in large bales or iron drums, while the home product is usually put up in bags.

The position with copper is even more difficult, for, whereas with brass some division can be effected under the headings of mixture and description—*e.g.*, tubes, sheet clippings, rod ends, etc.—distinctions in the red metal are not so fine, and only two or three broad categories exist. High conductivity copper wire for the crucible does not permit of much misunderstanding as long as the size of the pots is known, but when we come to that widely discussed term, "heavy copper scrap," then, indeed, we are among the shoals and shallows, and the course is set for trouble.

Ranging from braziery copper at one end of the scale to heavy crucible scrap, used very largely during the recent shortage of the best select brands for brass-making, at the other, we find an enormous variety of grades and descriptions of secondary material supposed to conform to the description, "good, clean, heavy copper scrap." Certain lines are, of course, usually offered separately, and very often a special price is obtained for cut-up firebox plates, stay bolts, clean locomotive tubes, and shell bands—when available.

Heavy Copper Scrap.

It is frequently difficult to determine just what constitutes heavy copper scrap, and it is useless to apply to textbooks or official publications for assistance, because the rights and wrongs of the case have never been set down in print, and conformity with the contract is ruled by the unwritten law of the scrap metal trade, which in practice varies in different parts of the country and in accordance with buyers' idiosyncracies. While one manufacturer sets great store by cleanliness, and will forgive a dealer for sending in material a bit on the light side as long as the loss from dirt is negligible, another plumps for close-lying, compact material and passes corroded tubes and painted ships' work without comment.

Another bone of contention is Post Office wire, disliked by many buyers for its heavy coating of oxide and the risk of receiving bronze instead of pure electrolytic copper. These big coils are not everybody's bargain, for unless the furnace doors are fairly large there may be some difficulty about charging, and, incidentally, it is worth remembering that the gang will run some risk of asphyxiation if they are running down a heat composed entirely or principally of this sea-green overhead wire, for the fumes are appalling.

Most buyers would refuse wire tendered against a heavy copper scrap contract, and they would be quite justified in so doing, for the average "furnace bundle" hides a multitude of sins in the shape of lead, cotton covering and other insulation, and dirt from wire which has been burnt off and improperly boshed. "It's a wise foundryman that opens his bundles," for it is curious how the bad stuff finds its way into the interior! No, if a merchant wishes to send in wire, he should mention the fact when quoting, and the buyer must ask for such safeguards as he deems necessary and reasonable.

Although it may not be practicable to grade scrap as in the States, where different sortings are registered under numbers from one upwards, much misunderstanding and friction might be eliminated in this country by rather more exact descriptions. If a dealer has a parcel of ship's copper to sell, let him say so openly, and his customers will then expect mixed deliveries and a fairly heavy loss from paint, dirt and foul pipes. Nothing is ever gained—in the foundry trade, at any rate—in misstating a case!

Mr. Robert Ellison, of J. G. Joicey & Company, Limited, engineers, Forth Banks, has died at Gateshead at the age of 75.

An Informal Discussion on Foundry Raw Materials.

At a monthly meeting of the West Riding of Yorkshire Section of the Institute of British Foundrymen, held at the Bradford Technical College, under the chairmanship of Mr. W. Parker, of Halifax, Mr. H. Forrest was to have lectured on "Iron and Carbon," but the subject was changed to that of a fairly general review of ironfounders' raw materials.

Use of Hematite Extending.

Mr. J. G. Robinson, opening the discussion, said it was an address which afforded great scope for going deeper into the subject. Mr. Forrest had mentioned the composition of different irons for foundry purposes. To-day the blast furnaces were laying themselves out to supply material pretty well to a chemical analysis—which was a good deal more than could formerly be said. In regard to bringing the analyses down, the common pig-irons could mostly be brought into line by the addition of hematites, as Mr. Forrest had mentioned. Mr. Robinson said he should think there were very few foundries to-day into which hematites did not find their way in order to bring the composition to what was required. Some mention had been made of the cost of hematite, but he (Mr. Robinson) did not think the cost of it was so great that it could be used more cheaply than Scotch irons. Mr. Robinson said he did not like thin steel sections when melting steel, but for a medium-sized furnace one need not trouble, he thought, in working a little beyond the 2 in. mentioned by Mr. Forrest. He himself remembered having used rejected steel shell material during the war, which was in pieces 4 in. square, and it melted through the cupola without any trouble. Mr. Forrest had suggested that phosphorus gained in remelting scrap. Personally, he (Mr. Robinson) did not quite see where there was such increase in re-melting irons. He thought really the only increase, if one reckoned 5 per cent. loss of iron, would be the difference between the 100 per cent. started with and 95 per cent.; that the increase in phosphorus was really only one of concentration. Phosphorus, indeed, was the one element which practically remained constant all the way through in re-melting iron. Mr. Robinson said he thought Mr. Forrest was perhaps hardly correct in his suggestions as to moisture in coke. He fancied anybody who tried to sell coke with 5 per cent. moisture would soon find their mistake. He imagined the figure of moisture in coke rather needed a decimal point before the figure given by Mr. Forrest, to bring it nearer the mark of the general condition of the coke. Mr. Robinson said he had been interested in the reference to the fluorspar discussion recently in The Foundry Trade Journal. If it was possible for anything to be added to reduce the sulphur content in melting in a cupola, there promised to be a fortune for the man who could do it. If Mr. Forrest had any further data on that subject, it would be very generally welcome.

Use of Fluorspar.

Mr. Forrest, replying, said in his references to hematite he was chiefly referring to steel foundry hematite, which was usually higher in carbon than in an iron foundry. In regard to sulphur in the cupola and the addition of fluorspar, he did not know that he had anything useful that he could add. The author of the Paper in The Foundry Trade Journal gave 20 per cent. limestone and 10 per cent. fluorspar as producing a sulphur reduction of 0.1 per cent. The article was only an extract, and did not go much beyond giving the figures.

Mr. W. H. Poole said the question of hot or cold blast for pig-iron was not so simple a problem as to be dismissed merely as a matter of dissolved oxides. It was, rather, chiefly a question of the smelting conditions. A slow-smelting furnace gave better conditions than a rapid-smelting furnace. If they took in virgin irons and smelted them down, they got a better result that with old scrap and a better physical condition than was not shown altogether by a chemical analysis. The chemical analysis was certainly very important, but the process of manufacture has a very great influence in the use of pig-iron. Mr. Poole said he agreed with Mr. Robinson in regard to hematite. Owing to the slackness of the steel trade there had lately been a great amount of hematite on the market. Hematites were usually very high total-carbon pig-irons, and if one utilised the pig accordingly one got toughness if the total carbon content in the mixture was controlled. Personally, he questioned the point as to using malleable scrap in the cupola. If one got much of it, and it was not sorted into a lot of charges, 0.4 per cent of sulphur could cause considerable damage. In regard to the suggested increase of phosphorus, Mr. Poole said it was not increased in melting except that one got an accumulative effect in having a quantity of shop scrap going back into the charges day after day. In reference to coke, the physical condition of it was a vital point. Personally, he would prefer a good physical condition with comparatively poor analysis rather than the reverse if he had to choose. The structure of the coke itself could have a serious influence on the cleanliness of the metal and the type of slag that was ultimately formed. Fluorspar, he quite agreed, had a certain value in it. If one had a poor lining condition or dirty scrap, one got a lining of slag if using limestone alone. To his view, from 2 to 5 lbs. to the ton charge was about sufficient.

Cold Blast Has Special Properties.

Mr. A. Jackson said the question of raw materials was of primary importance to every foundryman. The best of labour was of comparatively little value with poor tools and materials. With regard to hematite irons, he (Mr. Jackson) would emphasise the point made by Mr. Robinson that hematite was almost a necessity for most classes of work in the foundry. Hematite was in considerably more general use in Yorkshire than seemed to be indicated by Mr. Forrest's observations, and the price was not excessive, being very little more than that of ordinary foundry iron. In regard to cold blast or hot, there was much in that matter that the industry did not yet know. The fact that they could get as low as 0.5 per cent. silicon, and yet the iron was perfectly workable, suggested that there was some material difference between cold blast and hot blast. Mr. Jackson said he thought Mr. Forrest had rather overstated the case with regard to moisture in coke.

Core Oil Adulteration.

Some time ago he (Mr. Jackson) had attempted an experiment to find how much moisture coke would actually absorb. Whilst it was true that he was dealing with a good class of coke with a porosity of about 40 per cent.—which was very rare—the greatest moisture he could get it to absorb was 14 per cent. He fancied if a coke received by the foundryman had much over 2 per cent. in average moisture, there was good ground for complaint. With regard to the volatile matter, he did not see that it should be as high as 2 per cent. in good coke. Mr. Jackson said he agreed to some extent with Mr. Poole's suggestion that more importance was to be attached to physical structure of coke than to chemical analysis, but it seemed to him that there was a direct relationship between physical structure and chemical analysis. The percentage of ash in coke very largely determined the physical properties of the coke; it determined very largely the strength, the density, the brittleness of the coke. The lecturer had mentioned core oil. Mr. Jackson said he was convinced that the best core oil was a pure boiled linseed oil, and he was sorry to feel that there was a great practice among makers of core oil to add cheap mineral oils, which really had the effect of retarding the natural drying properties of the oil. In some cases, indeed, the maker has not even the decency to hide the evidence of his mistake, and one could see on the oil the bloom which indicated

the presence of mineral oil—a feature which could quite easily be "de-bloomed" if the makers thought it worth their while to disguise it. With regard to sand, Mr. Jackson thought probably the greater portion of the troubles of the foundry were due to the sand and the proportions of the sand used; many of the troubles, indeed, attributed to sulphur were quite misplaced, and were really due to the sand and proportion of sand. To get ideal results, of course, it would be necessary to stock two or three grades of sand and get a suitable mixture, but he quite agreed that that was hardly practicable where storage accommodation was limited. Any one ideal sand, he thought, was almost an impossibility.

Moisture in Coke.

Mr. Forrest, replying, said the coke to which he referred was certainly an unusually bad consignment, and the moisture had actually reached 12.5 per cent. It was a very wet day, and the coke had probably been standing a long time in the rain. That might have accounted for some of the excessive moisture. Usually, in his experience, they found cokes having 3, 3½ up to 5 per cent. of moisture. "I can see Mr. Robinson disagrees with me," added Mr. Forrest, amid laughter.

Mr. G. Nield pointed out that the moisture content of the coke was of no particular harm, apart from the fact that one was paying for weight of water instead of weight of coke.

The Chairman said he did not think the average coke was so wet as mentioned by Mr. Forrest when it left the coke-oven premises, and that was the point which was being questioned by Mr. Forrest's critics. The amount of moisture when delivered depended largely on whether the coke went direct to the foundry or had been standing in a truck in the rain for a week or two.

Mr. Nield said it would certainly be better for coke to be stored under cover.

Mr. Poole said, on the other hand, some foundrymen had an idea that if they damped the coke before putting it into the cupola it gave better results.

Sulphur Content and Hardness.

The Hon. Secretary (Mr. S. W. Wise) said the question of wet or dry coke had been discussed almost *ad nauseam*, and he doubted whether anybody could really say whether wet or dry coke was better in service. The difficulties the trade had had during the coal strike had shown foundrymen that they could do many things which they had previously thought were not practicable, and it had shown that the question of moisture in coke was not particularly bad, apart from the matter of paying for water instead of for fuel. Some coke which they would not think of using under normal conditions had come through use during the coal strike quite well. This thought brought one back to that other question of sulphur in iron. Was that, after all, such a bugbear as they had been accustomed to think? During the period of the coal strike they had not been able to get just the iron they wanted, and many of them found that in getting wrong irons their sulphur content soared. In his own experience, under these circumstances they had had sulphur fairly high, but they had not had any material trouble from the point of view of hardness. Mr. Wise said it would be interesting to know what members thought was the undesirable limit to reach with sulphur in a mixture for any particular class of work. The question of sands had been mentioned in the course of the evening, but he would have liked Mr. Forrest to have told them something about some materials which were more readily adulterable than sand—for instance, coal dust, blacking, plumbago, etc. He thought the trade could be satisfied that it was fairly sure of value for money in coke and iron, but there were some things in which they could not be anything like so sure; for instance, just what they sometimes bought as molasses. As regarded fluorspar, he thought most of them felt happier when they were not using it. It had been tried for quite a long time, but what benefit it gave in reduction of sulphur was counteracted largely by trouble with the lining of the cupola. They read a good deal of matter on this subject, sometimes expressed in terms not always very complimentary to the intelligence of the foundrymen, and he (Mr. Wise) would rather like to have heard what Mr. Forrest thought about the materials for lining the cupola.

Mr. Nield asked, enlarging on the use of fluorspar, whether a higher manganese content would reduce the danger of sulphur?

Mr. Forrest replied that it should be arranged so that the manganese content to reduce the danger from sulphur was by the use of a lime slag. If there was 0.1 per cent. of sulphur in the iron a balance would have to be arrived at, say, about 0.8 or 0.9 per cent. of manganese, to offset the danger of the increased sulphur content. He believed many people in the trade during the coal strike had been using a higher manganese pig if possible to reduce the danger of sulphur.

How High Sulphur Can Operate.

Mr. Robinson said he had often spoken on this subject to Mr. John Shaw, of Sheffield. Mr. Shaw, who worked with an air furnace, suggested that one could have high sulphur in cast iron, but it must be neutralised by two-and-a-half times the quantity of manganese.

Mr. Poole said if one has a very high sulphur content and low manganese, and if there was a low silicon content one produced a white iron. If one had a high silicon, high sulphur and low manganese one was likely to get an internal chill or a mottled effect.

A Member remarked that another curious phenomenon was that of small gas holes with a little pellet in the middle, the pellets probably consisting of phosphide eutectic.

Mr. Poole said they need not look upon sulphur as a great bogey if they could control it, and especially if they could get five to six times as much manganese.

Mr. Wise said it would be very interesting if one could know a safe limit figure. Many of the evil things predicted in the trade had not happened, as they should have done according to predictions, whilst using all sorts of materials during the coal strike.

Mr. Robinson suggested 0.1 per cent. of sulphur as the desirable limit.

Mr. Poole, however, qualified this by stating that in an ordinary general iron foundry if 0.1 or 0.2 per cent. of sulphur is reached, dangerous conditions were instituted.

Mr. Wise wondered how many foundries had kept their sulphur down to 0.1 per cent. in the last six months.

Mr. Robinson said undoubtedly in many of the castings made recently one of the saving features had been the addition of hematite.

Mr. Wise: But there are limits to the quantity of hematite one can add to a mixture.

Mr. A. S. Worcester said he thought during the coal strike, owing to the enforced use of Continental irons, there had been more trouble from higher phosphorus than from high sulphur.

In answer to a question as to the use of plumbago, Mr. Forrest said the value of plumbago lay in its fineness from a materials point of view. There was also, of course, an amount of combustible matter in it. If it burned leaving a high ash content it would not be of much use because the ash would be washed away and there would be scabbing on the surface of the sand where it was supposed to lie. Ceylon plumbago had a total carbon content of about 98 per cent.

Mr. Poole said some plumbago gave as high as 40 to 50 per cent. of ash if they got some very poor plumbago in certain physical conditions. The usual objection to plumbago was that if it washed at all it made dirty castings. The form of the plumbago had a big influence. Some good plumbagos contained 30 per cent. ash and gave very good results in service. The question of adulterated plumbago, of course, arose, and he had recently had a sample with 78 per cent. ash. That had altogether too much tendency to wash, but as a wet blacking it was rather satisfactory. Personally, he was always doubtful about judging plumbago on its analysis purely so far as concerned the question of ash content. One could get great value from shop tests as well as analysis.

Mr. Robinson said he believed the average moulder had a fairly good judgment of it.

Heat-Resisting and Non-Corroding Steels.*

PROGRESS IN THEIR DEVELOPMENT AND PRACTICAL APPLICATION.

By Sir Robert Hadfield, Bt., D.Sc., D.Met.

Nickel-chromium steels are already familiar to engineers in their well-established uses as high-tenacity steels possessing excellent ductility and toughness. Further research among the range of the nickel-chromium alloys of iron of considerably higher percentage has disclosed a highly promising field of alloys with many attractive properties, which, if they could be made use of, should prove of the highest value. The range of alloys concerned covers from about 10 to 35 per cent. of chromium, and about 5 to 60 per cent. of nickel, with an iron content of from 25 to 75 per cent. These alloys all possess certain general distinguishing characteristics as compared with ordinary steel. Among these are greater resistance to scaling by heat; improved strength at high temperatures and resistance to corrosion; they further do not undergo critical thermal changes on heating, and heat-treatment has not the same effect on them as in the case of ordinary steel. While, therefore, ordinary steels and many useful alloy steels undergo changes of structure on heating and cooling, these alloys have a homogeneous microstructure which remains the same under heating however long maintained, or under repeated heating and cooling. They therefore remain permanent in their physical character—naturally an important point in connection with heat-resisting steel.

The microstructure of "Era" heat-resisting steel shows a homogeneous grain structure and is typical of the alloys in this group. The small amount of free carbide up to 0.2 or 0.3 per cent. present in some cases does not affect their thermal stability. In their mechanical characteristics, as exhibited at ordinary temperatures, these alloys are in some ways rather different from what the engineer has by long use become accustomed to know as "steel." They are in fact of the general type known to the metallurgist as "austenitic steels," of which manganese steel, although quite distinct in many ways from those now described, was the original representative. The features of a high modulus of elasticity and high elastic limit common to ordinary steels, are lacking in these austenitic steels. Notwithstanding this, however, where such desirable qualities in other directions are obtained as in the case of the wearing qualities of manganese steel, this unorthodox character has not been found a disability. Such is indeed proving to be the case with the present alloys. It is necessary to mention this because the fact that they may not comply with existing specifications based on more ordinary steels, might otherwise, quite wrongly, be allowed to prejudice their uses in applications particularly suited to them.

As to the special physical qualities found in these high-percentage nickel-chromium steels, while it is true that they all partake of a heat- and corrosion-resisting character, all do not possess these qualities to an equal degree. Further, when various practical considerations, such as machinability and adaptability to other manufacturing operations are taken into account, as they must be, the development of the types most suited to particular uses becomes a matter of much patient research; the addition of elements other than nickel and chromium, such as tungsten, molybdenum and silicon in small percentages has further been found beneficial in obtaining the desired qualities to an enhanced degree in certain cases.

Heat-Resisting Steel.

At ordinary temperatures, as is well known, steel in general is more or less elastic, that is, under the tensile test it recovers its original dimensions after stretching up to a point not exceeding its yield point. On further stretching, the steel finally breaks under a stress, which, although not independent of the speed at which the test is carried out, is reasonably so within the range of speed of most testing machines. Thus, two of the important characteristics from which designs may be calculated, are determined more or less definitely.

When such a test is applied at a high temperature, say above 500 deg. C., it is found that ordinary steel no longer possesses the same elasticity, and as the temperature increases the yield point loses definiteness until it finally vanishes. Further, on carrying the test to completion, fracture besides occurring at a much lower maximum stress than in the cold, is much more easily accomplished if the test is carried out slowly than at a more rapid rate. While for example a specimen of 0.25 per cent. carbon steel at 800 deg. C. is broken in three minutes by applying a load of six tons per square inch, a load of only half a ton per square inch will cause fracture if allowed to remain for as long as 100 hours. Steels of all kinds in fact at high temperatures lose their highly elastic properties and become of a viscous character. While, therefore, steels of a heat-resisting character show up favourably under the ordinary tensile test at elevated temperatures, the method of discriminating between them must be modified if data of practical value are required.

Research on this question has demonstrated that if the load applied to any given steel at any particular high temperature is gradually reduced, a stress is reached at and below which no continuous stretching is produced, however long the load is maintained. The expression "continuous stretching" is used advisedly, because in some cases, and particularly at the higher temperatures, there is a slight extension—not more than about 0.5 per cent.—which, however, is not maintained. Under continued loading at the critical stress, this slight set becomes permanent, and no further stretching occurs. This critical stress, therefore, provides a useful criterion of the merits of a steel for use at high temperatures, and obviously one of use to the engineer as a basis for his designs. The determination of this stress, known as the "creep stress limit," or "creep stress," is, therefore, the method applied in testing the strength of heat-resisting materials. In the case of "Era" steel, the creep stress thus ascertained at various temperatures is as follows:—At 600 deg., 8 tons per sq. in.; 700 deg., 5 tons; and 800 deg., 2½ tons. These figures may appear to be rather low by comparison with the figures given by steel at ordinary temperatures, but when it is realised that under similar conditions—*e.g.*, at 800 deg. C., ordinary steel fails to support a load even of half a ton per sq. in. without continuous stretching, finally breaking in 107 hours, and that cast iron will break under even a quarter of a ton, it will be appreciated that "Era" steel represents a very considerable advance.

It would be difficult to find a more excellent example of what can be achieved in the field of heat-resisting steels than that performed by a turbine rotor, a forging, which, driven by the gases of an internal-combustion engine, has worked continuously at a temperature of from 800 to 900 deg. C. when running at a speed of 30,000 r.p.m. It has, in fact, been run up to a speed of 53,000 r.p.m. for testing purposes, and the peripheral speed was then some 2,200 ft. per sec. In these circumstances, the metal would be well above the red heat, and that it should be able under such conditions to withstand the centrifugal force produced at the speed mentioned seems worthy of attention by those interested in the development of the internal-combustion turbine.

A point to be mentioned is that the heat-resisting steels have distinct merits as non-corrodible steels, that is, at ordinary temperatures. In periods of disuse of plant, parts made from these steels do not, therefore, deteriorate or rust up as does ordinary steel, consequently less attention is necessary in re-starting.

* Abstract of a Paper read before the Institute of Marine Engineers.

Steel for Steam Turbines and Steam Fittings.

Since the introduction of the steam turbine, one of the problems met with in its use has been the effects of high temperature and of corrosion and erosion upon the blading. The consequences of actual breakage of the blading, with broken fragments running loose inside the turbine casing, can naturally be very serious. The report of a prominent insurance company for the year 1925, in fact, records four cases of steam-turbine breakdowns through failure of the gearing. Of these, one resulted from priming of the steam, one from erosion by wet steam, and two others from the presence of oil in the waste steam used, which clogged the blading and set up severe vibration. Other insurance companies, no doubt, have had similar experiences. Even where actual failure does not occur, there are many cases, especially in marine turbines, where either serious loss of efficiency or too frequent replacements of the blading are caused through its deterioration owing to the causes mentioned.

With progress always tending towards higher temperatures and pressures so as to achieve the thermodynamic advantages associated with them, the problem of erosion becomes ever more accentuated, and, in addition, materials of the more ordinary ferrous and non-ferrous types are unable, owing to their loss of strength at these high temperatures, to offer sufficient resistance to the severe and fatiguing stresses experienced in the blades. At the cooler end of the turbine the problem of corrosion still remains, especially where the steam, as is often the case, is contaminated. Thus, in the selection of the material for the blading, more than one factor has to be considered. In the absence of any one material able to meet each of the individual requirements, endeavours have been made, with a certain amount of success, where the conditions are not too severe, to meet the problem by the use of separate materials for the blades at the low-pressure and the high-pressure ends of the turbine, or even with a third material for the intermediate stage

Of ferrous materials, besides ordinary steel, steel containing 3 to 5 per cent. of nickel, stainless steel, and stainless iron, each with approximately 14 per cent. of chromium are used. Non-ferrous metals comprise chiefly various alloys of copper. None of these materials, however, is entirely satisfactory, and, according to the operating conditions, each displays weakness in one direction or another.

Stainless steel and iron offer improved mechanical strength and resistance to erosion and also corrosion at the high-pressure end of the turbine. Their mechanical qualities, however, deteriorate at the higher temperatures up to 750 deg. Fah. used in modern practice, while certain other disabilities attached to their use. Non-ferrous materials show excellent resistance to corrosion, but, although they are tough, lack of mechanical strength, especially in the higher ranges of temperature, renders them comparatively easily eroded, and unsuitable in those cases where centrifugal and fatiguing stresses are pronounced.

Consequently, the cases are still many where the problem of obtaining suitable material is not adequately solved. There has been a definite need for a material which cannot only be relied upon to behave satisfactorily in turbines in their present state of development, but also be so well above requirements that the engineer can be encouraged to go forward, unhampered by any such considerations as whether the blading material will be able to withstand the service imposed upon it. To arrive at such a material has been the aim of researches carried out over several years by the French Commentry-Fourchambault et Decazeville, and the Hadfield firm. These researches have resulted in the development of an entirely new type of material known as "Hecla/ATV" Steel, which, it is claimed, does in every way meet admirably the requirements for steam-turbine blades.

At ordinary temperatures and as usually supplied, ATV steel in bar form has a Brinell hardness of 200 to 240 with tensile properties as follows: Yield point 28-35 tons per sq. in., maximum stress 48 to 56 tons, and elongation 12 to 20 per cent. Where specially desired, however, it can be supplied in either a harder or softer condition; in the former case the Brinell hardness may reach 290 and the tenacity 64 tons per sq. in., at which the yield point is 45 tons, with a ductility of 10 per cent. In the softer condition the Brinell hardness may be as low as 160 with a tenacity of 38 tons per sq. in., and yield point 22 tons, the ductility reaching about 30 per cent. This flexibility in respect of its hardness is rendered possible on the one hand by the characteristic which ATV steel has, in common with other austenitic steels, of hardening under the effect of cold rolling, and on the other hand, by the ability to remove such hardness through a simple annealing process. Such methods do not, however, in any way affect the statements made as to the non-effect of heat-treatment upon ATV steel, as they do not constitute what is ordinarily understood by heat-treatment, and there is no accompanying change in the type of the microstructure.

Non-Corrodible Steel.

The final goal of a universally resistant steel at an economic price is not yet reached. The production of non-corrodible steel must in fact be regarded as a process of evolution, which can be traced in stages and in which rapid advances have been made within recent years. It is obvious that the problem of corrosion can only be adequately met by the use of a steel which is in itself non-corrodible, and does not rely upon any special surface protection. The first important step in this direction was the introduction of chromium steel, containing about 12 or 13 per cent. of this element, also with comparatively low carbon up to about 0.30 per cent., and which has become familiarly known under the name of "stainless" steel. The use of chromium steel in this direction is not the result of the efforts of any one individual, but rather of developments dating back many years and in which many investigators have taken part.

It does not seem to be sufficiently known that chromium steel possesses excellent advantages for many purposes where the effects of corrosion are experienced, that is, apart from domestic uses. It is not so generally resistant to various forms of corrosion as the more recent types of steel, and compares unfavourably in some other ways. At the same time, against the more ordinary types of corrosion, and when suitably heat-treated, it is able to render an excellent account of itself besides possessing special recommendations as a high-tenacity steel. For some engineering purposes, therefore, chromium steel can be recommended.

Ingot iron—really a steel in the method of its manufacture—in which a high degree of purity is aimed for, that is, freedom from all elements other than the iron itself, has proved distinctly more resistant to the more usual forms of corrosion than ordinary iron or steel. It has consequently achieved very considerable use for a variety of purposes. Thus in this instance some success against corrosion has been obtained not by alloying, but rather the opposite. On the other hand, within the past few years claims have been made also for the superior corrosion-resisting qualities resulting from the introduction of a small proportion of copper, not more than about ¼ per cent., into mild steel, and the use of such steel has been advocated especially for roofing sheets. While the full claims would perhaps be difficult to justify, such copper-bearing steel does seem to offer advantages in those cases, as in industrial districts, where the atmosphere is charged to an abnormal extent with products of combustion, that is, has a relatively high sulphur content.

The most recent types of non-corrodible steel may be regarded as a development from chromium steel, but constituting a distinct advance in important particulars. In the main this advance consists in the association of a comparatively high percentage of nickel with the chromium. One of the earliest investigations with regard to nickel-chromium alloys of iron was the French firm La Société Anonyme la Néo-Métallurgie. Their British patent obtained in 1903 points to the great resistance to corrosion offered by such alloys in which the nickel content is stated to vary between 5 per cent. and 60 per cent and the chromium

from about 24 per cent. to 57 per cent. It is further specified that carbon should be in a very small proportion and the alloy as a whole of a high degree of purity.

Since that date research has continued in progress and a more complete and detailed knowledge of the character of the iron alloys containing a high percentage of nickel and chromium has been obtained. In this progress the Hadfield firm has taken an active part, and the new type of non-corrodible steel known as Era/C.R. Steel represents the result of several years of experiment and research. Its chief advantages over chromium steel are not only in the more complete resistance which it offers to the ordinary forms of corrosion due to air and water, but also in the great range of corrosive agencies to which it is resistant. A still further advantage is that while chromium steel, to display its highest resistance to corrosion, must be heat-treated and carefully prepared as regards surface, "Era/C.R." is, so to speak, intrinsically non-corrodible and will display its qualities without special heat-treatment, and without specially careful machining.

In its ordinary forged or rolled condition with a Brinell hardness of 230, its tensile characteristics are: Yield point, 27; maximum stress, 52 tons per sq. in.; elongation on 2 in., 45 per cent.; reduction of area, 55 per cent. For the purpose of cold pressing it is necessary to use sheets which have been specially softened by heating them to 1,200 deg. C. and cooled quickly; in this condition it is supplied with a Brinell hardness of 150, the corresponding tensile figures being: Yield point, 15; maximum stress, 41 tons per sq. in.; elongation on 2 in., 75 per cent.; reduction of area, 70 per cent.

Sussex Iron Industry.

By Colonel H. C. Evans.

Cæsar stated that iron was produced in the maritime regions of Britain, and there is very little doubt that he referred to the Weald of Sussex. Professor Boyd Dawkins, in 1862, produced circumstantial evidence to this effect when he found rude pottery, and flint flakes on the top, and therefore, of a later date than a slag heap in Battle parish.(1) This points to iron smelting during, and probably towards the end of, the Stone age. There is plenty of evidence of activity in iron work during the Roman occupation (2), the most interesting object found being a small Roman statuette in cast iron, a process with which the Romans were at that time unacquainted. The method adopted for smelting was very primitive, and suggests a very elementary knowledge. Apparently a hearth of charcoal was first laid on which a layer of ore was placed, which, in its turn was covered with a layer of clay in order to retain the heat. The iron ran out at the bottom of the mound. This process was repeated, each set of layers being placed on their predecessors, with the result that a regular stratified mound 50 ft. high was formed, as in the case of the cinder heaps at Beauport and Bede.

Though iron was a valuable metal to a warlike race, there is plenty of evidence to show that for some reasons of their own the Saxons completely overthrew the industry. The Domesday Book only refers to one iron mine in Sussex, at East Grinstead. The industry lay dormant till 1250, when the Sheriff of Sussex was ordered to send 12,000 nails to Fremantle for roofing the hall, and in the following year to supply 30,000 horse shoes and 60,000 nails.(3) A few mines and iron works must have been in existence then.

Up to the reign of Henry VIII, when the historic period of the industry begins, though iron was worked in the county it was not to any large extent. Iron smelting was carried on in various parts of the Weald, but only in a small way. During Henry VIII's reign the industry was no longer a local but a national one. Deposits of iron are widely scattered throughout the whole geological district of the Hastings sands, stretching north from Hastings and bounded by the chalk hills of the North and South Downs. The ore mostly used was clay ironstone. The Sloan MSS. (4,020 folio 189) "Of the iron mines of the County of Sussex," published in the 18th century, gives interesting details, apparently exclusively of the various kinds of ore found, but, unfortunately, the MSS. is defective.

No Sussex furnace now exists, but in the valley of Cwn Aman, in South Wales, are the remains of one built by certain ironmasters who came from Sussex.(4) Roughly speaking, the furnace was a building 24 ft. square outside, with a height of 26 to 30 ft., containing an egg-shaped cavity, at the bottom of which was a floor of sandstone and the iron vent of the bellows. These latter were at first worked by foot blast, but by the middle of the 16th century water power was chiefly used. Once the furnace had been lit it was kept burning, sometimes as long as forty weeks, the period of blowing being reckoned in "foundries," each of which lasted six days, or the working week; and during each "foundry" an average of eight tons of iron would be made at the expense of 24 loads of charcoal of 11 quarters each, and as many loads of mine (ore) at 18 bushels to the load. These figures are taken from the contemporary work of Walter Burrell, of Cuckfield, and refer to the end of the 17th century. The great heat of the furnace reached its maximum about 10 weeks after the start, and more or less rapidly ate away the sandstone hearth, "so that at first it contains so much as will make a sow of 600 or 700 pounds weight, at last it will contain so much as will make a sow of 2,000 pound." Consequently, the hearth had to be renewed after every period of blowing. Having been cast into sows it had to be forged. The forge, iron mill or hammer was a building with two open hearths, the "finery," the "chafing," and a great hammer of about seven or eight hundredweight worked by a water mill.

The greater part of the iron manufactured in Sussex, apart from ordnance, was disposed of in bars of such a size that they could be easily worked into plough shares.

In 1664 the number of iron works was given in the Sussex Arch. Coll. xvi as 50,000. While the mineral wealth of the county was coming to the fore there was a danger that its valuable stores of timber would be lost. Though the loss in timber might be held to be balanced by its gain in mineral wealth, there was a point of national interest involved. This was the export of ordnance to foreign nations, especially to Spain, with whom our relations were always very strained. Seizures of contraband iron were frequent, no fewer than 14 cases occurring in 1591. In order to check this illicit export monopolies were created. About 1627 attempts were made to induce workmen in iron mines at Maresfield to give their services to foreign employers.(5)

During the Civil War a certain amount of injury was done to iron works held by the Royalists. The period of the Commonwealth was at first one of great activity, especially during the Dutch war, but was succeeded by a period of slackness; so much so, that of the 27 furnaces, 17 of which cast ordnance and shot, working in 1653, seven were completely ruined in 1664, and 10 others had been discontinued. Their repairs were only completed shortly before that date, when the war brought a revival of trade. The reason for this depression, according to the Grand Jury at Lewes in 1661, was the importation of Swedish and other foreign iron at low rates with the object of capturing the English trade. A recovery took place in the trade at the end of the 17th century, but the discovery that mineral coal for iron smelting was better than wood fuel brought a dangerous competitor into the field. By 1740 there were only ten furnaces in the county, in 1785 only two, and in 1796 only one. This was at Ashburnham, and it was abandoned in 1822.

(1) Sussex Arch. Coll. xlvi, 2.
(2) Sussex Arch. Coll. xxix, 173.
(3) Sussex Arch. Coll. xvii, 17.
(4) Arch. Camb. Ser. 3 ix, 86.
(5) Cal. State Papers. Domestic 1627-8, pp. 196-254.

John C. Parkes & Sons, Limited.—Net profit, £1,615; brought in, £1,793; from reserve, £2,000; available, £5,408; final dividend, 2 per cent., making 4 per cent.; carried forward, £988.

The Desulphurising Action on Molten Iron of Some Chemical Components Containing Fluorine.

E. Wilke and H. Buchholz* have studied the effect of some fluor compounds on molten iron with respect to the sulphur content. They started from the assumption that the desulphurising action of these compounds which is well known in the case of fluor spar must increase with the increasing reactability of the compounds. The analysis of the iron used in the experiments was as follows: C 3.35, Si 1.56, Mn 0.63, P 0.38, and S 0.22 per cent. The slag with which the iron was covered contained 0.23 per cent. of sulphur. The melts (500 grs. of iron and 125 grs. of slag) were prepared in a fireclay crucible which was put into a graphite crucible and heated in a gas-fired furnace.

Table I.

No.	Fluor Compound.	No. of Melt.	Analysis of Iron. S.	Analysis of Iron. Mn.	Analysis of Slag. S.	Decrease of Sulphur in the Single Melts. Iron.	Decrease of Sulphur in the Single Melts. Slag.	Total Decrease of Sulphur. Iron.	Total Decrease of Sulphur. Slag.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	$Na_2 Si F_6$ ..	1	0.220	0.45	0.224	0.0	2.6	—	—
		2	0.220	0.36	0.220	0.0	1.7	—	—
		3	0.215	0.29	0.213	2.3	3.1	2.3	7.4
2	$Ca F_2$ .. (Fluorspar)	1	0.220	0.31	0.215	0.0	6.5	—	—
		2	0.210	0.265	0.205	4.55	4.3	—	—
		3	0.205	0.239	0.183	2.27	9.6	6.82	20.4
3	$Mn F_2$ ..	1	0.195	0.48	0.212	11.4	7.8	—	—
		2	0.170	0.36	0.195	11.4	7.4	—	—
		3	0.155	0.24	0.171	6.8	10.4	29.6	25.6
4	$Na_3 Al F_6$ ..	1	0.200	0.24	0.205	9.1	10.9	—	—
		2	0.175	0.10	0.192	11.4	5.6	—	—
		3	0.140	0.073	0.178	15.9	6.1	36.4	22.6
5	$Mn Si F_6$ ..	1	0.180	0.47	0.203	18.1	11.7	—	—
		2	0.135	0.38	0.182	20.5	9.1	—	—
		3	0.110	0.21	0.155	11.4	11.7	50.0	32.5

Table II.

No.	Fluor Compound.	No. of Melt.	Analysis of Iron. S.	Analysis of Iron. Mn.	Desulphurisation of the Iron. Single Melt.	Desulphurisation of the Iron. Total.
			Per cent.	Per cent.	Per cent.	Per cent.
1	$Na_2 Si F_6$	1	0.210	0.20	4.55	—
		2	0.200	0.14	4.55	9.1
2	$Ca F_2$	1	0.205	0.17	6.8	—
		2	0.190	0.10	6.8	13.6
3	$Mn F_2$	1	0.190	0.22	13.6	13.6
4	$Mn Si F_6$	1	0.190	0.25	13.6	—
		2	0.170	0.22	9.1	22.7
5	$Na_3 Al F_6$	1	0.180	0.20	18.2	—
		2	0.155	0.17	11.3	29.5

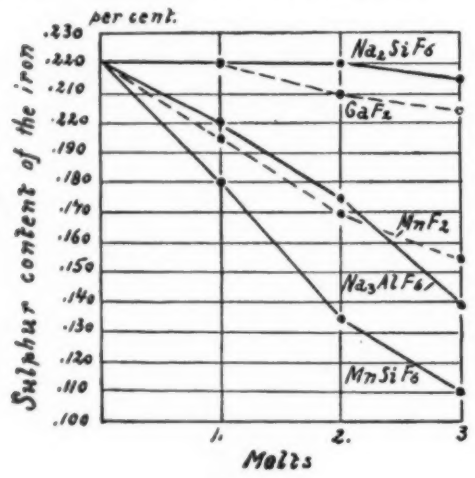

Fig. 1.

The results of the first experiments were very irregular because of the bad contact between the fluor compounds which were added in a powdered state and the iron. In the following experiments 5.0 grs. of each fluor compound were pressed together with 20.0 grs. of iron to a briquette and added to the molten iron in this form; the samples were melted three times. The reaction between the fluor compounds and the iron took place rapidly; after a period of 30 minutes no fluor gas could be observed in the gases. The experimental results are recorded in Table I and Fig. 1. The fluor compounds are arranged according to their desulphurising effect. The fact that the action of the sodium compound is minor to that of fluorspar may be explained by the high volatility of this compound; in fact, a great part of the added material was found sticking to the lid of the crucible. In the following experiments no slag was used. The added quantity of each fluor compound was equal to 8.5 grs. of fluorspar. The results are recorded in Table II. It is to be seen that the sequence of the compounds has not changed, but that the desulphurising effect is greater than in the case when a layer of slag is used.

* Stahl und Eisen, December 23, 1926.

Merchandise Marks Act, 1926.

Inquiry by the Standing Committee (General Merchandise).

With reference to the recent announcement, the Standing Committee state that they will begin the inquiry with regard to certain descriptions of imported iron and steel on Monday, April 25, at 2 p.m., and, if necessary, the Committee will sit on the morning and afternoon of Tuesday and Wednesday, April 26 and 27. The descriptions of iron and steel covered by the inquiry are as follows:—

(1) Steel.—Plates, rails, joists, angles, channels, sectional material of all descriptions, castings, forgings, rounds, squares, flats, hexagons, hoops, hot and cold rolled strip.

(2) Wrought iron.—Bars, hoops, sections, plates and sheets.

The sittings of the Committee, which will be open to the public, will be held in Room 74a, First Floor, New Public Offices, Great George Street, London, S.W.1.

Representatives of any interests substantially affected by the applications made for the purpose of requiring the above-mentioned classes and descriptions of goods to bear an indication of origin, who desire to be heard in opposition, are requested to communicate with the Secretary of the Committee, Mr. E. W. Reardon, at the New Public Offices, Great George Street, London, S.W.1, not later than April 19.

Nickel Coatings.

At a Joint Meeting of the London Section of the Institute of Metals and the Electroplaters' and Depositors' Technical Society, Mr. W. R. Barclay, O.B.E., A.M.I.E.E., gave a lecture entitled "Nickel Coatings—Methods of Production," Mr. A. H. Mundey (chairman) presiding.

The lecturer said that the object of his Paper was to call attention to the three methods of applying pure nickel as a coating to other metals which in any degree had found commercial application. They might be described as (1) rolled metal coatings; (2) sprayed metal coatings; and (3) electro-deposited metal coatings.

Before dealing with the first method the author gave a brief description of the commercial production of malleable nickel.

With regard to the production of nickel-coated steel, using malleable nickel, he said that the details of the rolling of the compound material varied quite appreciably in various works. The process was originally evolved in both Germany and Belgium.

One method of treatment was to hot-roll the steel down to a suitable slab, say, 1 in. thick, and to hot- or cold-roll the nickel down to a thickness bearing some proportion to this, say, 5 or 10 per cent. The steel is then given a coating of electrolytic copper in the cyanide vat, and the nickel sheet, made chemically clean, is laid immediately on the top and pressed together mechanically. The two metals are then heated to a temperature of about 850 to 900 deg. C. and immediately hot rolled.

The German method is essentially simpler than this: the electrolytic coating of copper is eliminated. Very elaborate precautions, however, are taken in order that the surfaces to be rolled together shall be absolutely chemically clean. It is also, however, necessary to prepare the compound billet before hot rolling so that every trace of air can be excluded, and the method of doing this constitutes the secret of this process. There is no difficulty whatever in obtaining a perfect weld between the coating and its base metal, and it is very rare that any trouble is found with regard to adhesion after hot rolling. The compound billet is usually hot rolled down to about ⅜-in. thick and the "rate of flow" of the two metals is remarkably uniform. The steel usually shows slightly at the edges and the ends, but only to a very limited degree. After hot rolling the metal is thoroughly pickled and cleaned, and taken on to steel rolls for finishing. The difficulty which has probably been the greatest factor in hindering the general adoption of this process is the fact that it does not provide adequate protection to the edge of the sheet against corrosion. However, in Germany, particularly, it was used to a great extent for small arms ammunition in addition to the similar compound metal cupro-nickel-on-steel. He understood, also, that one or two German producers of nickel had placed a considerable number of cooking utensils on the market at one time or another.

There was another difficulty, however, namely, that of obtaining a perfectly sound surface. As a coating is rarely more than one-tenth of the total thickness of the sheet, and that total thickness may be only perhaps 0.04-in., the nickel itself must be definitely sound in order to avoid the fine pits or pores which are so fruitful in producing points of attack for either the atmosphere or any other corrosive agent.

Generally some method of test, such as a salt spray or potassium ferro-cyanide test, was adopted, but the percentage of rejections was usually large and he (the lecturer) doubted whether this method of producing nickel coatings would have anything but a limited application in the ordinary way.

It was worthy of attention, however, in that it enabled coatings of nickel to be applied to steel of appreciably greater thickness than was feasible with other methods.

The "Schoop" Process.

The production of coatings of metal by means of the "Schoop" metal spraying process is now familiar to most metallurgists and metallurgical workers and very successful coatings of nickel have been applied by this method. The "Schoop" spraying piston is designed to take wire and, therefore, any metal to be used for coating must be in the form of wire. In the case of nickel the product used is commercial malleable nickel wire 1.0 mm. dia.

In the preparation of metals for the purpose of spraying it is necessary to observe the same standard of cleanliness as is familiar to workers in any other branch of metallic deposits, but it is also necessary to subject the surface to sand blasting, which at the same time cleans and slightly roughens the surface and so secures increased adhesion. In practical work it has been found possible to apply any thickness of coating from 0.001 in. upwards.

Sprayed nickel coatings closely resemble cast nickel in both physical and mechanical properties. A sprayed coating can be filed, machined, ground and polished. It is, however, brittle and has a low tensile strength and a rather low specific gravity compared with the rolled metal. After spraying it cannot be drawn or rolled cold, but its properties in this direction are much improved after annealing in hydrogen.

Comparing this method with others producing nickel coatings it was perhaps hardly necessary to point out that sprayed coatings were not resorted to when considerations of resistance to atmospheric corrosion were the main factors.

Sprayed nickel coatings were used to a very large extent where iron or steel was to be protected against certain gases and liquors met in practice. Nickel, apart from its resistance to corrosion, had the added advantage of presenting a hard surface and, therefore, was at the same time capable of resisting erosion to a considerable extent. It therefore provides an ideal coating when the corrosive liquors contain sand, grit and other hard substances in suspension. Wherever protection from strong alkaline solutions was required nickel was undoubtedly the best metal to use. Sprayed nickel was to all intents and purposes equivalent to cast or rolled nickel in its chemical properties.

Electro-Deposition.

With regard to the production of nickel coatings by means of electro-deposition, the lecturer pointed out that there had been very much more research work in this direction during the last few years than there had been done formerly.

He (the lecturer) thought it was not too much to say that in electro-nickel-plating shops where all these factors were under scientific control and minute attention was paid to the details of high-class works practice, the electrolytic method of producing nickel coatings was without rival. The advantages were fairly obvious.

In the first place there was scarcely any limit to the complexity of size and shape of the objects which were to be plated. It is also possible to obtain deposits of considérable hardness, and indeed, where necessary, to regulate the degree of hardness of such deposit, a factor not easily, if at all, controllable in other processes.

Alternate Coatings of Cu and Ni.

Speaking on the question of the protection given by electro-deposited nickel coatings against corrosion, particularly with regard to the rusting of iron and steel, the lecturer said he had recently had an opportunity in America of studying the process of giving iron and steel alternative coatings of copper and nickel. He had watched this process in actual operation at the C. G. Spring & Bumper Works, in Detroit, and had an opportunity of inspecting their results and noting also the results not only of the laboratory salt spray test, but the actual wear and tear records. There was no doubt whatever that this process gives a very efficient protection against rusting, and when carried out in a properly organised shop, such as the one mentioned above, there was practically no increased expense. A brief description of the process was then given.

While considerable progress has thus been made in the technology of the electro-deposition

of nickel, there are still a few problems outstanding which call for further investigation. One of these is the brittleness which is often found in electro-deposited nickel on annealing. Electro-deposits of nickel have often been produced during recent years which in the normal condition have a ductility apparently little, if any, less than that of malleable nickel produced in ordinary metallurgical practice.

A further factor of importance, which he (the lecturer) was glad to hear was receiving attention in researches now being carried out in the University of Sheffield, is that of strain in electro-deposited nickel, but there is considerable work yet to be done in this direction. On the whole, however, the present technological position of the nickel-plating industry can be said to be quite healthy and its future can be looked forward to with considerable hope.

There is one factor, however, which it is essential to stress in any consideration of the place of nickel plating in modern industry, and that is the necessity for scientific control of works processes, with particular attention to the physical condition of the deposit and its thickness. The future of the nickel-plating industry depends on workers combining to prevent the sending out of all edged nickel-plated work in which the deposit is so thin as to give no possibility of reasonable satisfaction in wear.

One thing stands out in a study of the subject, and that is the peculiar suitability of nickel as a coating for other metals. It is hard in the sense of being considerably resistant to abrasion and surface wear; it is hard also in the sense of having considerable tensile strength; it is resistant to heat and to electricity; it ranks very high in the list of the elementary metals which resist corrosion, whether by liquid or gas; and with all these it combines a brilliant whiteness of colour which renders it exceedingly attractive. It is perhaps also worth while adding that while it is not found in such large quantities in the earth's strata as its sister element, iron, all indications point to the fact that it is present in sufficient quantity to remove any anxiety as to its use and to put it very high in the ranks of the elementary metals which are available for the service of man.

The Iron and Steel Institute.

Programme of Annual Meeting.

Mr. G. C. Lloyd (Secretary) has issued the programme of the Annual Meeting of the Iron and Steel Institute, to be held, as previously announced, at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, May 5 and 6.

THURSDAY, MAY 5.

The General Meeting will open at 10 a.m., when the Annual Report and Statement of Accounts for 1926 will be presented. The newly-elected President (Mr. F. W. Harbord, C.B.E.) will then be inducted into the Chair, and, following the presentation of Bessemer Gold Medals to Mr. Axel Wahlberg and Professor C. Benedicks respectively, will deliver his Presidential Address. Papers Nos. 13 and 5 (see appended list) will then be discussed until 1 p.m.

At 2.30 p.m. the Afternoon Session will commence, when Papers 7, 8, 17 and 10, will be discussed.

In the evening, at 7.30 p,m., the Annual Dinner of the Institute will be held at the Connaught Rooms, Great Queen Street, W.C.

FRIDAY, MAY 6.

At 10 a.m. the General Meeting will be resumed. An announcement of the award of the Andrew Carnegie Research Scholarships for 1927-8 will be made and Papers 3, 9, 6, 14 and 16 will be discussed. In the Afternoon Session Papers 4, 1, 2, 11, 12 and 15 will be taken in the order named.

Papers to be Read at the Meeting.

(1) "The Ac_1 Range in Special Steels," by J. H. Andrew and H. A. Dickie.

(2) "The Properties of Some Nickel-Chromium-Molybdenum Steels," by J. H. Andrew, M. S. Fisher and J. M. Robertson.

(3) "The Drawing of Steel Wire and its Relation to Qualities of Steel," by E. A. Atkins.

(4) "Theory of the Growth of Cast Iron Repeatedly Heated," by C. Benedicks and H. Löfquist.

(5) "An Experimental Inquiry into the Interactions of Gases and Ore in the Blast Furnace," by W. A. Bone, L. Reeve and H. E. Saunders.

(6) "The Influence of Annealing Temperature on the Properties of Mild-Steel Sheets," by C. A. Edwards and J. C. Jones.

(7) "The Metal Manganese and its Properties: also the Production of Ferro-Manganese and its History," by Sir Robert Hadfield.

(8) "Low-Carbon Alloys of Iron and Manganese," by Sir Robert Hadfield.

(9) "Heat-Resisting Steels," by W. H. Hatfield.

(10) "Alloys of Iron Research, Part VIII:—The Constitution of Alloys of Iron and Phosphorus," by J. L. Haughton.

(11) "A Further Investigation of the Indentation Hardness of Metals," by K. Honda and K. Takahasi.

(12) "The Phenomenon of Temper-Hardening in Steels," by T. Matsushita and K. Nagasawa.

(13) "Some Aspects of the Technical and Economic Conditions of the Heavy Metallurgical Industry of the East of France, with Particular Reference to the Utilisation of Gases and Motive Power," by J. Seigle.

(14) "Some Notes on Cold-Rolled Strip Steel," by T. Swinden and G. R. Bolsover.

(15) "Notes on Pseudo-Twinning in Ferrite, and on the Solubility of Carbon in Alpha Iron at the A_1 Point," by S. Tamura.

(16) "The Manufacture of Steel in India by the Duplex Process," by B. Yaneske.

(17) "Alloys of Iron Research": Introductory, by W. Rosenhain. Part V.—Preparation of Pure Chromium, by F. Adcock; Part VI.—Preparation of Pure Manganese, by Marie L. V. Gayler; Part VII.—Preparation of High Purity Silicon, by N. P. Tucker.

Autumn Meeting at Glasgow.

As already announced, the holding of the autumn meeting in Canada having been found to be impracticable, the President and Council of the West of Scotland Iron and Steel Institute intimated that they would be pleased to extend a cordial invitation to the Institute to meet at Glasgow in September. The invitation has been accepted with great pleasure by the Council, and a reception committee has accordingly been formed, consisting at present of the President and Members of Council of the West of Scotland Iron and Steel Institute as follow:—Mr. John Craig, C.B.E. (President); Messrs. A. Anderson, W. G. Turnbull, Louis Ripley, R. Crichton, R. Hamilton and J. MacGregor (Vice-Presidents); and the following Councillors: Messrs. F. P. Nowery, J. R. Cunningham, J. Bird, W. H. Cathcart, J. Mitchell and G. Ness, Dr. A. McCance, Messrs. T. B. Mackenzie, John Colville, J. Bryden and R. S. Wilson, Col. Alan Stein, M.C., Messrs. E. H. Lewis, M.A., and Douglas A. MacCullum (Secretary and Hon. Treasurer), Local Hon. Secretary of the meeting.

The meeting will be held in the week beginning Monday, September 19, the first day of the meeting being Tuesday, the 20th, and the last day Friday, the 23rd. The sessions for the reading and discussion of papers will take place in the Royal Technical College, George Street, Glasgow, and will occupy the mornings of Tuesday, Wednesday and Thursday, the 20th, 21st and 22nd of September. The afternoons of those days will be devoted to visits to works, and the reception committee contemplates the organisation of daily luncheons and various social functions in the evenings. All these functions will be held at the Central Station Hotel, which will be the Headquarters Hotel. On Friday, September 23rd, it is hoped to arrange an all-day excursion on the Clyde. Ladies are cordially invited to accompany members to the meeting, and special arrangements will be made for their entertainment.

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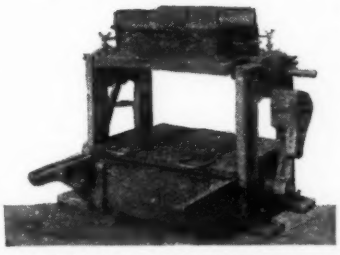

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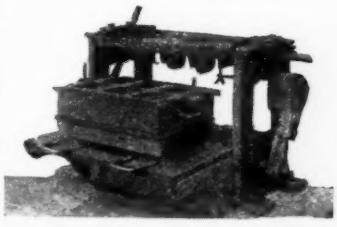

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Trade Talk.

The mills at the Wern Tinworks, Briton Ferry, owned by Baldwins, Limited, have been restarted.

Baldwins, Limited, who had decided to close the Landore Steelworks indefinitely owing to lack of orders, have now arranged that two of the mills shall for the time being remain in commission.

A Belgian tender by a Charleroi firm for electrical machinery required by the Manchester Electricity Department to the amount of just over £4,000 has been accepted by the Manchester City Council after a long discussion. It was alleged that there was something in the nature of a ring among the British firms who had sent in tenders all over £1,000 in excess of the foreigner.

James Keith & Blackman Company, Limited, Arbroath, have purchased the property in Arbroath known as Applegate Works, for long owned by Corear Brothers. The works have been closed down for some time, and the machinery is in process of disposal. The Applegate Works property lies directly opposite James Keith & Blackman's main building, and is thus conveniently placed for extension purposes.

An explosion occurred at Dorman, Long & Company's Newport Works, Middlesbrough, recently. Most of the workmen had left at 12 o'clock, and the few who were on duty at the time were not in the immediate vicinity of the boiler which exploded. J. Richardson, foreman electrician, who was working on the gantry round the boiler, was blown some distan e and received serious wounds. Other men had narrow escapes.

Samuel Osborn & Company, Limited, Clyde Steel Works, Sheffield, recently celebrated their seventy-fifth anniversary. From small beginnings at 180, Broad Lane, Brookhill, Sheffield, the firm has grown until at the present time it owns four large works, has branches in South Africa and Canada, and agents throughout the world. Directly associated are the firms of Burys & Company, Limited, and the Titan Trackwork Company, Limited, both of Sheffield.

Lecturing before the members of the Royal Society on the subject of "Alloys of Iron and Manganese of Low Carbon Content," Sir Robert Hadfield said when his firm during the war decided to make manganese steel helmets for the troops they found that on no account must it be heated above 400 degrees Centigrade. He added that England had no supplies of rich manganese ore, while in America supplies were scanty. He suggested that scientists in this country should carry on researches to see if they could not find some substitute to render us independent of foreign supplies to some extent.

The Great Western Railway Company, as owners of the Plymouth Docks, decided that an improvement should be made in the handling of traffic with the view of speeding up the work, and in this connection they have installed a belt conveyor. This conveyor, which was built by Fraser & Chalmers, Limited, is balanced upon a central pivot, and when not in use is turned parallel to the quayside. When a tender is brought alongside the pier the conveyor is pivoted so that the lower end rests upon the deck of the tender, whilst the other end feeds on to a small platform immediately in front of the mail van doorway. The belt is electrically driven and is capable of a speed of 260 ft. per minute when fully loaded. The balanced pivot and suspension of the belt enables tenders to be discharged at any state of the tide.

New Companies.

A. Butterworth & Sons, Limited.—Capital £10,000 in £1 shares, to acquire business of brassfounders carried on by J. Butterworth, J. P. Butterworth and A. Butterworth, at Ellesmere Street, Hulme, Manchester, as A. Butterworth & Sons. Directors: J. Butterworth, 90, Dudley Road, Whalley Range, Manchester, brassfounder (chairman); J. P. Butterworth, 2, Wellington Crescent, Manchester, S.W., brassfounder; and A. Butterworth, Tower Green, Acton Bridge, Northwich, brassfounder. Secretary: A. Weaver.

Central Ironworks (Walsall), Limited, Central Ironworks, Wisemore, Walsall. — Capital £1,000 in £1 shares. To acquire the business of malleable and general ironfounders, carried on by T. Longmore and T. H. Longmore, as Central Ironworks (Walsall), at Wisemore, Walsall.

Thomas McDowell, Limited, Swan House, 133 and 135, Oxford Street, W.1.—Capital £3,000 in £1 shares. Heating, ventilating and general engineers, metal workers, galvanisers, etc. Directors: T. McDowell (permanent), F. McDowell and Dorothy C. McDowell.

Personal Paragraphs.

Sir Guy Wrightson, chairman of Head, Wrightson & Company, Limited, Teesdale Ironworks, and his co-directors have been the recipients of an illuminated address to mark the men's appreciation of their successful efforts in keeping the works going fully during the past eight months of depression.

Wills.

Haslam, Sir Alfred Seale, head of the Haslam Foundry and Engineering Company £1,064,393

Jones, J. W., of Danycoed, Baglan, Briton Ferry, managing director of Thomas Jenkins & Son, Limited, Briton Ferry £2,139

Readhead, J., of Rockcliffe, South Shields, a director of the Tyneside shipbuilding firm of John Readhead & Sons, Limited £558,842

Tawse, James, West Ferry, Forfarshire, and Dundee, a director of the Caledon shipbuilding and Engineering Company, Limited £133,017

Meynell, Walter, of Wolverhampton, chairman of Meynell & Sons, Limited, brassfounders, of Montrose Street, Wolverhampton £17,007

Contracts Open.

Caledon, C.P., April 30.—1,410 lengths of 9 ft. of cast-iron pipes, 1,165 lengths of 3 in. and 247 lengths of 4 in., together with specials, sluice valves, etc., for the Municipal Council of Caledon. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,467.)

Cape Town, May 6.—Cast-iron pipes, special castings, valves, etc., for the Municipality of Stellenbosch. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,470.)

Dundee, April 16.—Iron, steel, etc., iron castings, brass fittings, etc., and plumbers' lead and iron pipes and fittings during the six months to November 15, 1927, for the Town Council. The City Engineer, City Chambers, Dundee.

Johannesburg, April 23.—Tramcar spares (rolled steel tyres, cast-steel wheel centres, and steel axles), for the Municipal Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,469.)

Market Harborough, May 18.—362 yards of 7-in. and 150 yards of 4-in. cast-iron mains, sinking a well, and an engine-house, for the Urban District Council. Mr. H. G. Coales, engineer, Council Offices, Market Harborough.

Company Reports.

Brown, Bayley's Steelworks, Limited.—Dividend on preference shares, due on March 31, passed.

Lancashire Dynamo and Motor Company, Limited.—Dividend, 5 per cent., less tax, on ordinary.

Wilkes, Limited.—Loss of £1,489 for seven months to July 31, 1926; debit balance forward, £13,878; debit carry forward, £15,367.

Nant-y-Glo & Blaina Ironworks Company, Limited.—Dividend, 30s. per share, less tax, on preference shares, on account of arrears.

James Cartland & Son, Limited.—Net profit, £3,768; brought in, £7,534; available, £11,302; preference dividend paid; carried forward, £7,552.

Company Meeting.

General Refractories Company, Limited.—The fourteenth annual meeting of the company was held on March 23, at the new general offices, Wicker Arches, Sheffield, the chairman, Mr. Frank Russell, presiding. The chairman said he was glad to be able to announce that, despite the disastrous effects of the protracted coal dispute, the company's sales during the financial year had reached a total only a trifle under those of their record year of 1925. This was due to the varied nature of the company's business, which meant that they were not actually dependent on any one section of industry, and was the result of a policy which would be continued and extended in the future. The meeting closed with a declaration of the usual dividend, and a vote of congratulation to the directors and staff on their success in maintaining the profit-earning capacity of the company in so difficult a year.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—In view of the impending Easter holiday, business in the Cleveland iron market this week is practically idle, while in the existing condition of high-cost production, there can be but a faint prospect of improvement in the early future. Consumers continue to purchase for only immediate requirements, with the object of compelling a further reduction in prices, but makers have not yet arrived at the point where concessions become essential. There is not yet any serious accumulation of stocks anywhere, although the stagnation in the home trade and the virtual extinction of export business indicate that a modification of current values cannot be long delayed. Current quotations meantime remain as follow:—No. 1, 82s. 6d.; No. 3 G.M.B., 80s.; No. 4 foundry, 79s.; No. 4 forge, 78s. 6d. per ton.

In the Tees-side hematite market weakness is rather more pronounced than a week ago. East Coast mixed numbers are now being quoted at 84s. per ton, but this figure could be shaded without difficulty for any substantial quantity. On the North-West Coast quotations are unchanged, Bessemer mixed numbers being £4 14s. 6d. per ton delivered at Glasgow, £4 15s. 6d. per ton delivered at Sheffield, and £5 1s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—Foundry pig producers supplying local markets are now evidencing a disposition to offer easier terms to consumers. In the case of Derbyshire brands, No. 3 quality has been on offer at a reduction of from 6d. to 1s. 6d. per ton, bringing current quotations, delivered Manchester or equal distance, to 89s. to 90s. Scottish brands of foundry iron have displayed further easiness during the last few days, and supplies could be bought, delivered Manchester, at round 103s. per ton.

THE MIDLANDS.—At Birmingham last week only a limited volume of business was transacted, with prices at about previous levels. Current quotations rule about as follow:—No. 3 Northants iron is offered at 79s. to 80s.; Derbyshire, 81s. 6d. to 82s. 6d.; and Staffordshire No. 3, 81s. to 82s. 6d., all free on trucks at the furnaces.

SCOTLAND.—The demand for Scotch foundry pig continues very poor, and, although makers are getting no relief in costs and say they are now getting to a point where the selling price is unremunerative, quotations continue to ease, and No. 3 foundry is quoted to-day at 85s. per ton, f.o.t. furnaces.

Finished Iron.

In most of the branches producing finished materials manufacturers are in urgent need of new business, and it is with the utmost difficulty that they can keep going with anything like regularity. Keen competition is prevalent for crown iron, and prices differ almost with every transaction.

Scrap.

Quiet conditions are again reported in most centres of the scrap metal trade, especially as regards foundry trade material, and in Scotland last week heavy machinery cast-iron scrap was easier, due undoubtedly to pig-iron being more plentiful. It is understood that even offers to consumers at 79s. per ton have been turned down. Heavy ordinary cast-iron scrap is 74s. to 75s. per ton, and for old cast-iron railway chairs 80s. per ton. Steelworks cast-iron scrap in furnace sizes is also easier at 71s. 3d. to 72s. 6d. per ton. Clean heavy turnings are in moderate demand around 50s. per ton, with cast-iron borings at about 47s. 6d. per ton. Light cast iron and firebars are also easier at 57s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—In the market for standard copper, the position continues to some extent uncertain, though fluctuations in values are comparatively limited in range and the tendency is fairly steady. Consumers being on the whole well covered, but producers at the same time fairly well sold up, there does not seem to be much to be expected in the way of fluctuations either way, although quotations in America have been lowered slightly, despite the trade reports being generally encouraging.

Official closing prices of standard copper have been as follow :—

Cash: Thursday, £55 to £55 2s. 6d.; Friday, £54 17s. 6d. to £55; Monday, £54 13s. 9d. to £54 16s. 3d.; Tuesday, £54 16s. 3d. to £54 18s. 9d.; Wednesday, £54 13s. 9d. to £54 16s. 3d.

Three Months: Thursday, £55 12s. 6d. to £55 15s.; Friday, £55 7s. 6d. to £55 10s.; Monday, £55 6s. 3d. to £55 8s. 9d.; Tuesday, £55 7s. 6d. to £55 10s.; Wednesday, £55 6s. 3d. to £55 8s. 9d.

Tin.—The more immediate effect of the official figures of the March returns, showing an increase in the total visible supplies of 1,220 tons, has been a slight decline in values, with a downward tendency. Home stocks have increased, and it is expected that further quantities will be added to this in the early future, which should assist in bringing down the premium on cash tin to an even less onerous level so long as there is no urgent American demand for prompt shipment.

Official closing prices of standard tin have been as under :—

Cash: Thursday, £309 10s. to £309 15s.; Friday, £306 15s. to £307; Monday, £305 to £305 5s.; Tuesday, £303 10s. to £303 15s.; Wednesday, £305 to £305 5s.

Three Months: Thursday, £299 15s. to £300; Friday, £298 10s. to £298 15s.; Monday, £297 5s. to £297 10s.; Tuesday, £296 10s. to £296 15s.; Wednesday, £297 5s. to £297 10s.

Spelter.—The market for ordinary spelter has been generally dull and easier, with but a slow demand from consumers, while Continental reports were none too good, and the American market has indicated renewed weakness, notwithstanding the expectation of some decrease in the output. Given a recovery in the deliveries over the spring, the establishment of better prices is not unlikely.

The following are the week's prices :—

Ordinary: Thursday, £29 13s. 9d.; Friday, £29 15s.; Monday, £29 10s.; Tuesday, £29 12s. 6d.; Wednesday, £29 16s. 3d.

Lead.—Soft foreign pig has been affected by a disappointing trade demand, but the market transactions shows some resistance at a moderate set-back, while a better Continental demand has been experienced, and the arrivals so far this month have been somewhat lighter. Consumption being again towards improvement both in Europe and America, there is a fairly confident feeling that the remainder of the surplus stocks will be easily taken care of.

The week's prices are appended :—

Soft foreign (prompt): Thursday, £26 17s. 6d.; Friday, £26 17s. 6d.; Monday, £26 15s.; Tuesday, £27; Wednesday, £27 3s. 9d.

From the Horse's Mouth.

Mr. C. W. Gay, of the Premier Foundry Company (Gay Brothers), 71, Salt River Road, Cape Town, South Africa, says in a letter just received "I would also like to point out for the benefit of any Foundry Supply Concern the difficulty of obtaining any supplies of first-class foundry sundries, such as plumbago, core gum, and chaplets. I feel sure an agency for general foundry supplies would be appreciated."

Holley Permanent Mould System.

An error crept into the report of Mr. D. Sharpe's remarks on this process given before a meeting of the Newcastle Branch of the Institute of British Foundrymen. He was reported to have said that by means of an acetylene flame a coating of carbon 1-32 in. was formed. Actually this referred to a special refractory material that is used in connection with the process, the smoking only being of infinitesimal thickness.

Paris Conference.

The Institute of British Foundrymen has accepted an invitation on behalf of their members to take part in the Conference of the French Foundry Technical Association which will be held in Paris from September 7 to 10, 1927. A complete programme of Papers and works visits, including a visit to the French Foundry High School, is being arranged. There will also be a number of social functions, and a special programme is being prepared for ladies.

Mr. T. Makemson, the General Secretary of the Institute of British Foundrymen, is already making preliminary arrangements for its members and those of allied societies who wish to take part in the conference, and further particulars will be announced in due course.